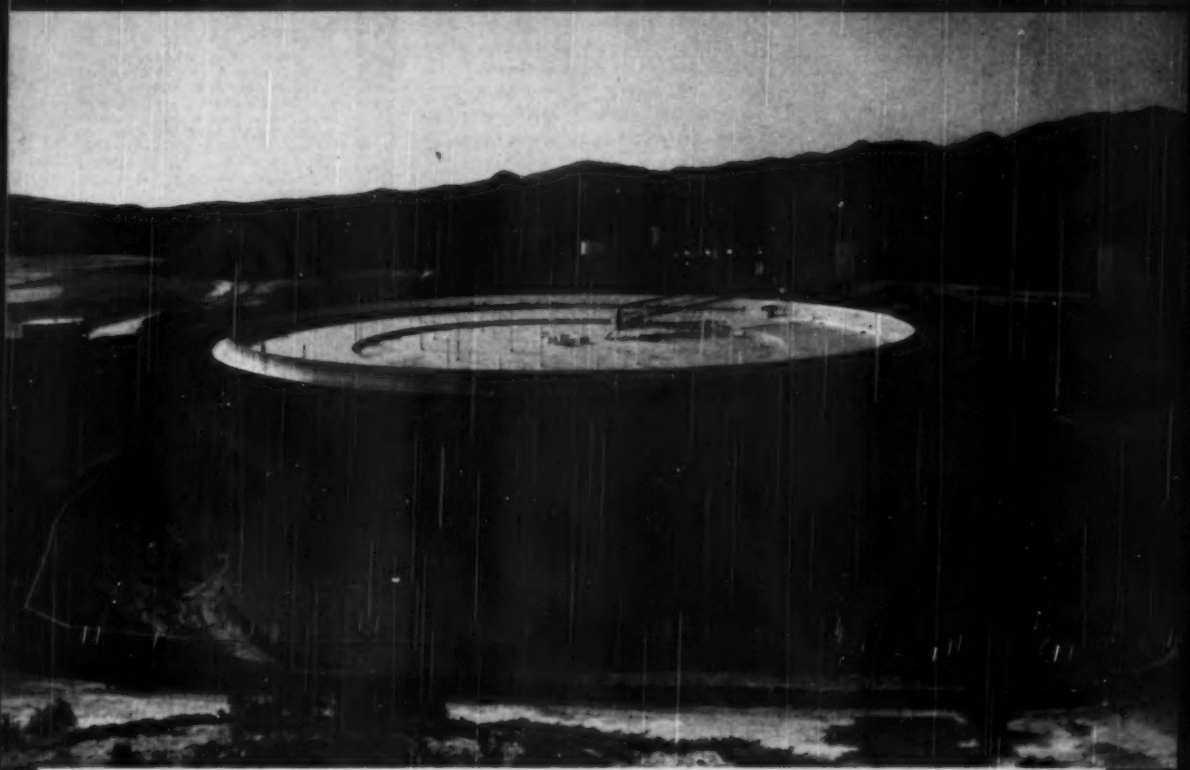
PETROLEUM REFINER

NOV. 1950

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETROCHEMICAL ENGINEERING, OPERATION AND MANAGEMENT



THIS flat-bottom tank is equipped with a Horton* Floating Roof. As the view clearly shows, the roof floats directly on the liquid in the tank. It thereby eliminates the vapor space that exists in fixed-roof tanks. By eliminating the vapor space, Horton Floating Roofs reduce evaporation loss, cut down corrosion and eliminate the fire hazard.

The Horton Floating Roof is built in three types . . . the *Double-Deck*, the *Pontoon* and the *Pan*. The first has a double-deck over the entire surface of the liquid; the second has an annular pontoon around the outer edge and a deck of single thickness at the center; and the third has a deck of single thickness. The roof shown above is a Horton Pontoon Floating Roof. Where "boiling" losses are a factor we recommend either the Double-Deck or the Pontoon depending on the insulation required to prevent boiling. Write the nearest office for information on all three types.

*Trademark registered in United States Patent Office . . .

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NOW—Simpler, Faster, Automatic Titrations!

Here's another new Beckman advancement in instrumentation—*an instrument that runs your titrations for you.* It's the Beckman Automatic Titrator—the instrument that makes accurate titrations more rapidly and conveniently than by manual methods.

SIMPLE OPERATION: In a series of titrations, simply fill the burette, place the sample in the beaker—and the Beckman Automatic Titrator takes over from there. Raising the beaker holder into position automatically starts the stirrer motor and begins delivering titrating solution into the sample.

A special circuit electrically anticipates the approaching end point, scaling down delivery of the titrating solution in progressively smaller increments to assure a highly accurate titration. When the end point is reached, delivery of the titrating solution stops and a light shows completion of the titration—*all automatically and without attention from the operator.*

Whether your laboratory is large or small the Beckman Automatic Titrator provides important advantages in your titrating operations...

- *It releases the technician during titration, enabling him to perform other operations such as preparing samples, or calculating results.*
- *It eliminates the fatigue caused by close observation required in manual procedures.*
- *It gives objective, reproducible results... eliminates errors due to personal factors.*
- *It provides time-saving conveniences for sample handling.*

PERFORMS A WIDE VARIETY OF TITRATIONS—Neutralization, Oxidation-Reduction, Precipitation, Complex-Formation and other types.

NO SPECIAL TRAINING IS REQUIRED—rapid and accurate titrations can readily be performed without special skill or technique.

QUICK, SIMPLE OPERATION—completes many routine titrations in only 1-1½ minutes—even titrations to 0.1% accuracy in 2½ minutes or less. Change of sample is simple, rapid—a single motion raises, locates and secures new sample in operating position.

CONVENIENT, VERSATILE, ADAPTABLE—0° to 100° C temperature compensation . . . adjustable holder accommodates 10 ml to 400 ml beakers or similar vessels . . . instrument may be used with all standard burettes down to 5 ml . . . as many as four delivery units accommodated by single amplifier control unit . . . . uses standard Beckman electrodes . . . electrode holders and delivery tip can be pivoted into any required position . . . ample provision for mounting heating devices or other special equipment.

ALSO A RELIABLE pH METER—the Beckman Automatic Titrator can also be used as an AC-powered pH meter to give accurate readings over the range 0 to 14 pH, as well as millivolt readings from −600 to +1400 mv.

For full details on this new Beckman instrument see your authorized Beckman dealer—or write direct. *Beckman Instruments, National Technical Laboratories, South Pasadena 25, California.*

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for the refining-natural gasoline industry

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for the drilling-producing-pipe line industry

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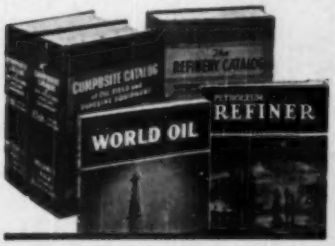

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PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

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VOLUME 29, No. 11 — NOVEMBER, 1950

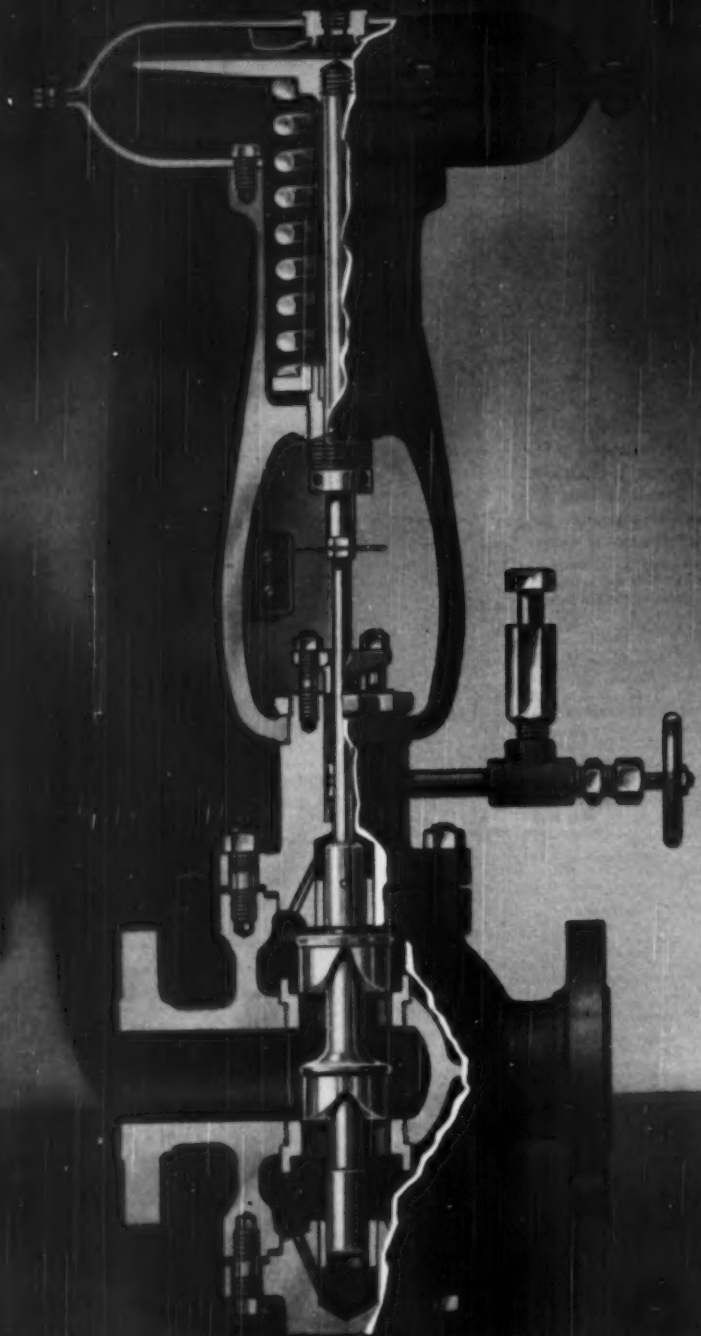
Contents

- **Adequate Defense Calls for Industry-Military Coordination** . . 85
  E. Brewster Jennings
- **PAD Designed to Protect Industry's Free Competition** 92
  An interview with J. R. Parten, consultant to Petroleum Administration for Defense.
- **Sweetening and Desulfurization of Light Petroleum Products, Part I: Introduction** 97
  The first article of a series on the chemistry and treating procedures used by refineries processing sulfur bearing crude oils. A parallel series to start shortly will present mechanical details of typical treating plants.
  V. A. Kalichevsky
- **Welding Quality Controlled in Petroleum Refinery** 101
  The qualification testing of welding operators, continued sampling and welding inspection of jobs in progress, the selection of suitable electrodes for various specific applications, and adherence to carefully developed welding procedures constitute vital parts of any workable refinery maintenance program.
  A. P. Bissar
- **Interpretation of Earnings Changes in an Oil Company** 109
  A practical procedure for accounting for the differences between sales and the cost of sales from one period to another in terms of principal causes.
  E. W. Kornmeyer
- **Planning Refinery Heat Transfer Equipment, Part III: Economical Proportions** 113
  Most product-to-feed heat exchangers have as their primary purpose the conservation of heat, the lowering of overall product manufacturing costs. Various heaters, coolers, condensers, and the like may serve primarily process functions; but their optimum design also must be based on the operation that will provide the best over-all economics.
  Tyler G. Hicks
- **Equipment Eliminated in New Sulfuric Acid Process** 116
  New design estimated to provide a twenty percent saving in capital investment.
- **A system of Process Calculations for Light Hydrocarbons, Part II: Equilibrium Considerations** 117
  Printed forms reduce the time requirement of light hydrocarbon process plant design by providing an orderly computation procedure and by decreasing the amount of material that the engineer must write into his calculations.
  A. J. L. Hutchinson
- **New Oil Blending Plant One of Largest in the Country** 123
- **Catalytic Cracking, Part IV** 125
  The concluding article of this series contains a section of suspensoid cracking and notes on the relative operating considerations of fixed-bed and moving bed catalytic cracking processes.
  Marshall Sittig
- **New Oil Drums Made from Old One** 133
  Conveyor-line methods provide efficient reconditioning of used containers.
- **Metallic Gaskets Given Boost by Oil Industry Development** . . 135
  The oil industry makes use of innumerable joints that must be easily disassembled and reassembled in lines and process equipment handling a wide range of pressures and temperatures and fluids. It has been the most important factor in the growth of the metallic gaskets industry.
  H. H. Dunkle
- **Multicolumn Reflux Still Promises Large Savings** 140
  New molecular still design appears to have commercial possibilities for the separation of liquids which differ in their molecular weights or vapor pressures but have similar properties otherwise.
- **The Chemistry of the Acid Treatment of Gasoline** 142
  A review of the reactions that can and do take place during this common treatment process.
  George E. Mapstone
- **Fractionating Unit Stabilizes Crude Oil** 151
  Simple unit separates pipe line mixtures of crude oil and natural gasoline.

DEPARTMENTS

The Look Box 81
Refinery and Other Plant Construction 96
Refiner Authors and Other Personalities 134
How to Do It 158
The Month in the Industry 163
The Oil Man's Calendar 170
Science and Technology Abstracts 183
Compiled by Dr. E. H. Leslie and Dr. H. B. Coats
Digest of United States Patents Pertaining to Petroleum 191
Compiled by Helen Heinemann
New Equipment, Manufacturers' Literature 207
Book Reviews 232
About Equipment and Service Suppliers 239
Index to Advertisers 254

Attention to Detail



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MASONEILAN
Air Operated
CONTROL VALVE
PERFORMANCE

The new Masoneilan Control Valves are outstanding examples of the results obtained by thorough attention to design details and exacting standards in manufacture.

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The result is a valve which gives you the performance that you have a right to expect.

We invite your detailed inspection — note the care taken to insure stem, seat rings, plug, bonnet and blindhead alignment, the responsive and powerful diaphragm motor, resistance to corrosion, adequate lubrication. Note, also, the *extras* which provide so much practical usefulness — the indicator plate graduated in ½-inches actual travel; the serial plate which gives you *full* valve specifications, the external adjusting screw for setting spring initial; the yoke detachable without disturbing bolted stuffing box; the open structure providing ample room for servicing stuffing box and attaching positioner take-off linkage; the two integral mounting pads for controller or positioner and air regulator-filter dripwell.

Practical engineers will appreciate Mason-Neilan's realistic approach to the control valve problem — and Mason-Neilan's latest answer. May we send you our new bulletin?

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These Valves Meet the Rigid Requirements and Specifications of the Most Exacting Users

Want your tubes to last longer, cost less—or both? Ask the experts!

This month Timken reports on:

18-8 STAINLESS

An austenitic, non-magnetic alloy that shows the best combination of creep strength, oil corrosion resistance and oxidation resistance for service up to 1500° F. For use in oil cracking systems, hydrogenation equipment, high temperature oil and steam piping, superheater elements, heat exchangers.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	16-13-5*
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20*
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-12*
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

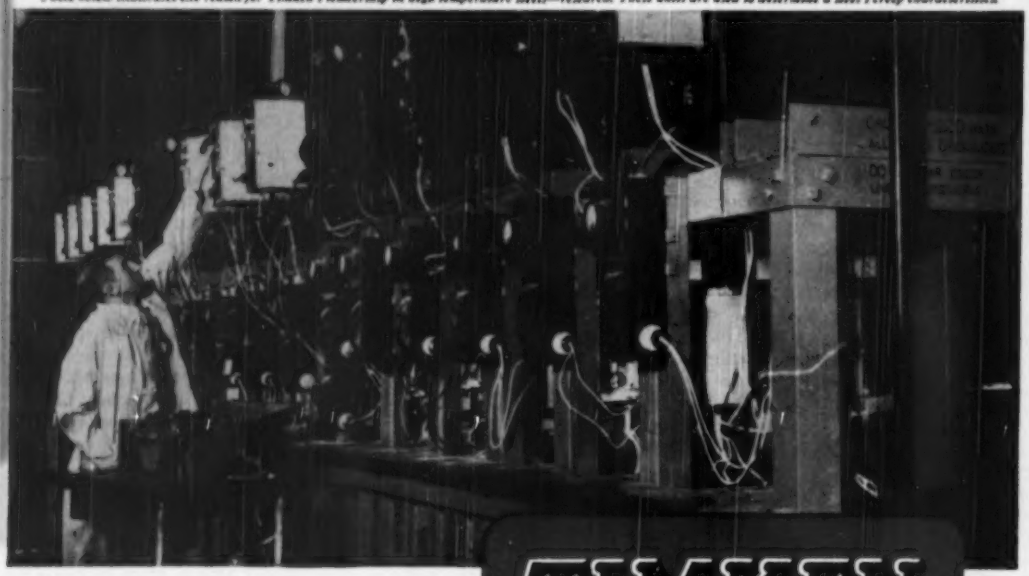
** Available as seamless tubing on an experimental basis only.*

ONLY *one* high temperature tube steel can give you the best life/cost ratio. It's the steel that's tailor-made for your particular operating conditions.

To make sure you select the *right* steel, get the help of the acknowledged experts in this field—metallurgists of The Timken Roller Bearing Company. They're backed by more than 20 years of outstanding research. By the widest field experience. By a range of 23 high temperature steels. By *uniform* tube quality—assured under Timken's complete, rigid control from melt shop through final inspection.

Let Timken's "RSQ"—Research, Supply, Quality—solve *your* tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio.

Photo below illustrates one reason for Timken's leadership in high temperature steels—research. These units are used to determine a steel's creep characteristics.

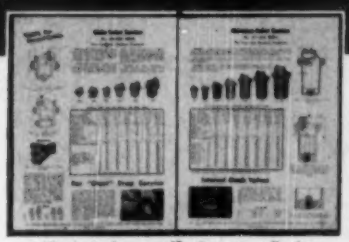


YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

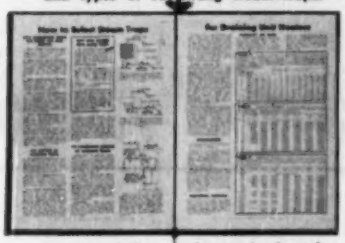
Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

"You can engineer any trapping job with this book"

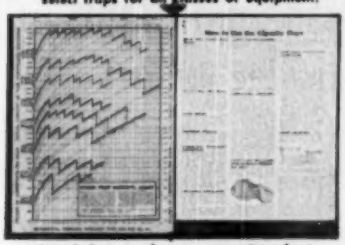
YOU CAN'T GO WRONG



Physical data and prices on all sizes and types of Armstrong steam traps.



How to calculate condensate loads and select traps for all classes of equipment.



Actual hot condensate capacity chart for every Armstrong trap, recommended safety factors and specific recommendations for many types of equipment.

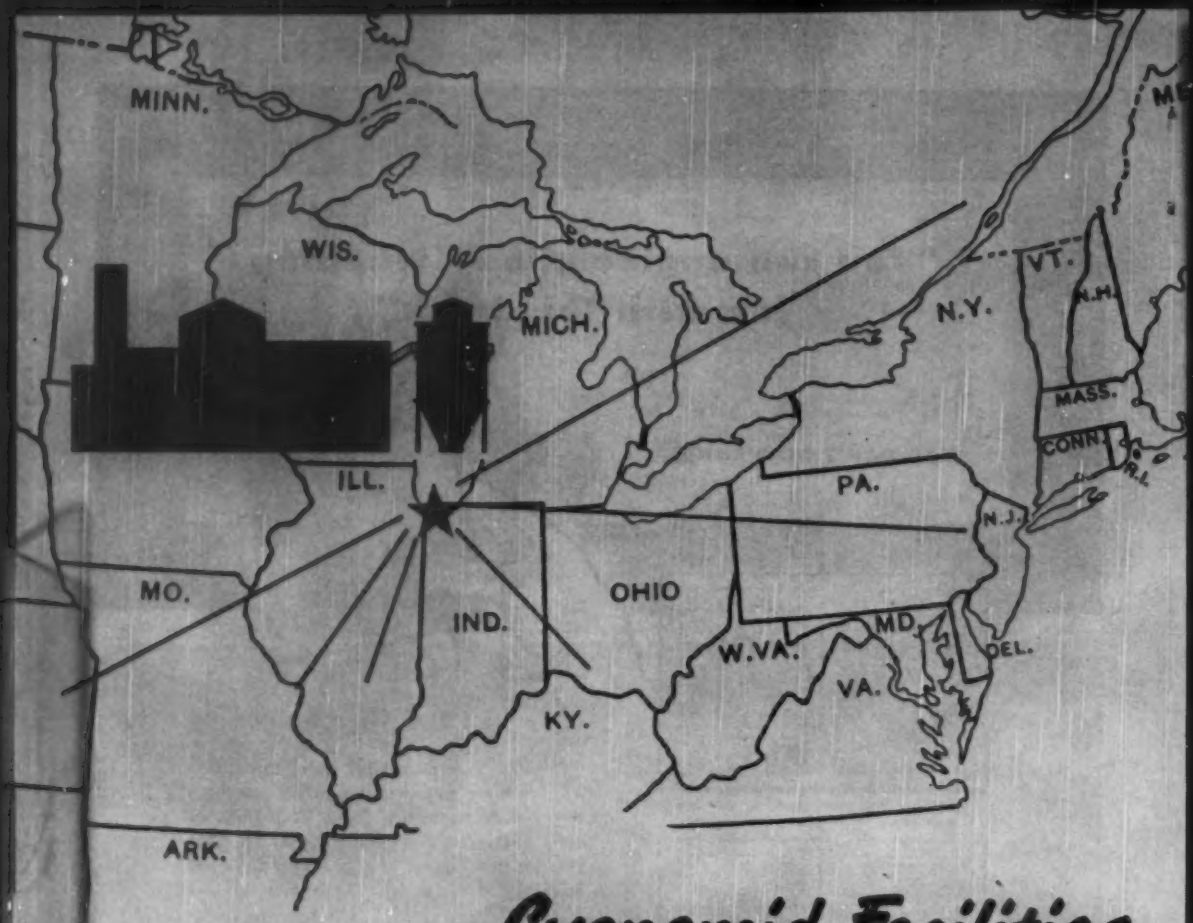
THERE is no guess work about steam traps or steam trap selection when you have the 36-page Armstrong Steam Trap Book to work with. You don't waste money on traps that are too big for the job. You don't get inefficient drainage with traps that are too small.

This book explains the design, operation and advantages of Armstrong steam traps, specifies materials used, gives complete dimensional data, includes list prices, actual capacities under working conditions. There are 10 pages of tabular and technical data explaining how to calculate condensate loads and select the correct trap for the job, complete instructions on installation and maintenance. The Steam Trap Book also describes Armstrong traps for draining moisture from compressed air systems, Armstrong steam humidifiers for adding moisture to dry air and Armstrong non-condensable gas purgers for removing air from refrigeration systems.

Anyone is welcome to a copy of this useful guide to good trapping practice. Send for yours today.

ARMSTRONG MACHINE WORKS
852 Maple St., Three Rivers, Mich.

ARMSTRONG STEAM TRAPS



Cyanamid Facilities . .

in the Chicago Area—a New Cyanamid Plant...

to meet MS Catalyst needs in the East and Mid-West

Supplementing...
Cyanamid's Ft. Worth Plant

serving the West and Southwest

Now under construction, Cyanamid's new plant at Michigan City, Indiana, is scheduled for completion in 1951. When operating at capacity, it will greatly increase the company's production of AEROCAT® Microspheroidal Synthetic Fluid Cracking Catalyst. The new plant will serve refineries on the Eastern seaboard and in the Middle-West, as well as refineries in Canada . . . supplementing Cyanamid's facilities at Ft. Worth which supply MS and ground catalyst to the Southwest and West.

Cyanamid's Performance Record

1942—Cyanamid starts production of synthetic fluid cracking catalysts at Ft. Worth to help refiners meet the demand for high octane fuel.

1946—Cyanamid expands Ft. Worth plant.

1946—Cyanamid becomes the *first* company to manufacture microspheroidal cracking catalysts on a commercial scale.

1948—Cyanamid expands production of MS catalyst at Ft. Worth in anticipation of growing demands.

1950—Cyanamid starts construction on new MS catalyst plant at Michigan City as refining demands continue to grow.

Tomorrow—Cyanamid research, proven production techniques, and expanded facilities will bring you greater quantities of uniform, high quality AEROCAT catalysts.

pattern for Leadership

Vision, Experience, Facilities, Service... is the combination that enables Cyanamid to produce better chemicals for the petroleum industry: AEROLUBE® Additives for motor oils... AERO* Specialty Catalysts for chemical processes...Gasoline Dyes and Drilling Mud Chemicals. To learn more about these products and how they can help you...

send today for samples and literature.

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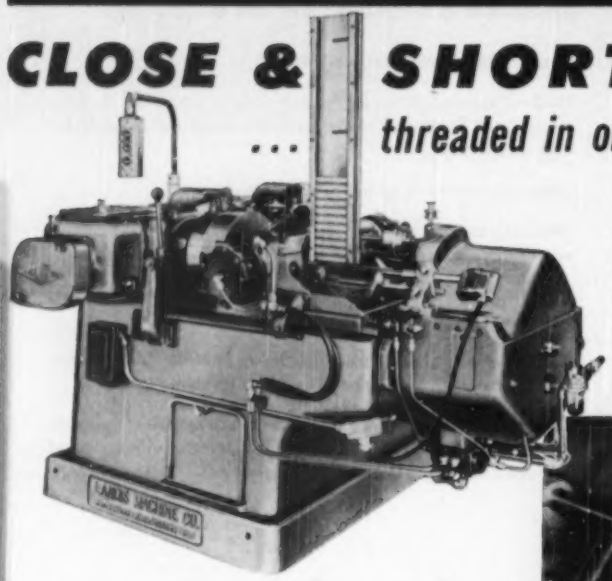
When Performance Counts...
Call on Cyanamid

AMERICAN Cyanamid COMPANY

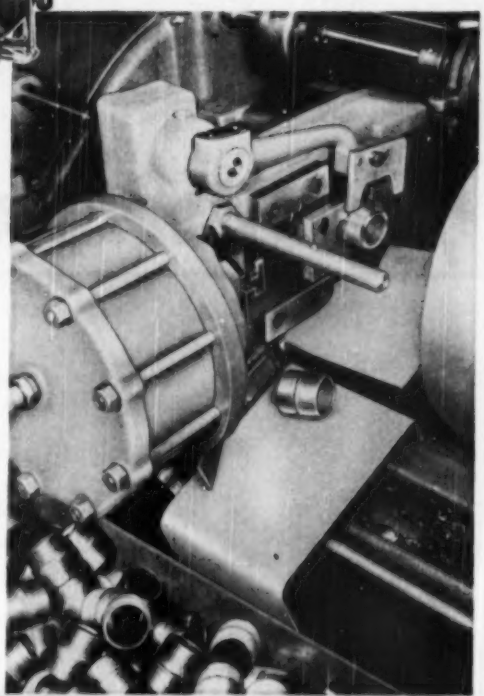
PETROLEUM CHEMICALS DEPARTMENT, DIV. A 11
30 Rockefeller Plaza, New York 20, N. Y.

A REVOLUTIONARY NEW DEVELOPMENT

CLOSE & SHORT NIPPLES ... *threaded in one automatic operation*



Formerly the production of close and short nipples was featured by high labor cost, low output and tedious manual handling. NOW . . . here is a modern machine tool which mass-produces these nipples in a single continuous automatic operation.



The LANDIS Automatic Close Nipple Threading Machine, recently perfected by Landis Thread Engineers, will produce commercial standard close, short, and special short nipples at rates ranging up to 625 per hour. These machines are built in two size ranges—one for ½" to ¾" nipples—the other for 1" to 2" nipples.

This new LANDIS Close Nipple Machine is completely automatic—threading, reaming, and chamfering close nipples on both ends without secondary manual handling. Nipple blanks are fed from a magazine, transferred automatically from one carriage to the other, and ejected when finished.

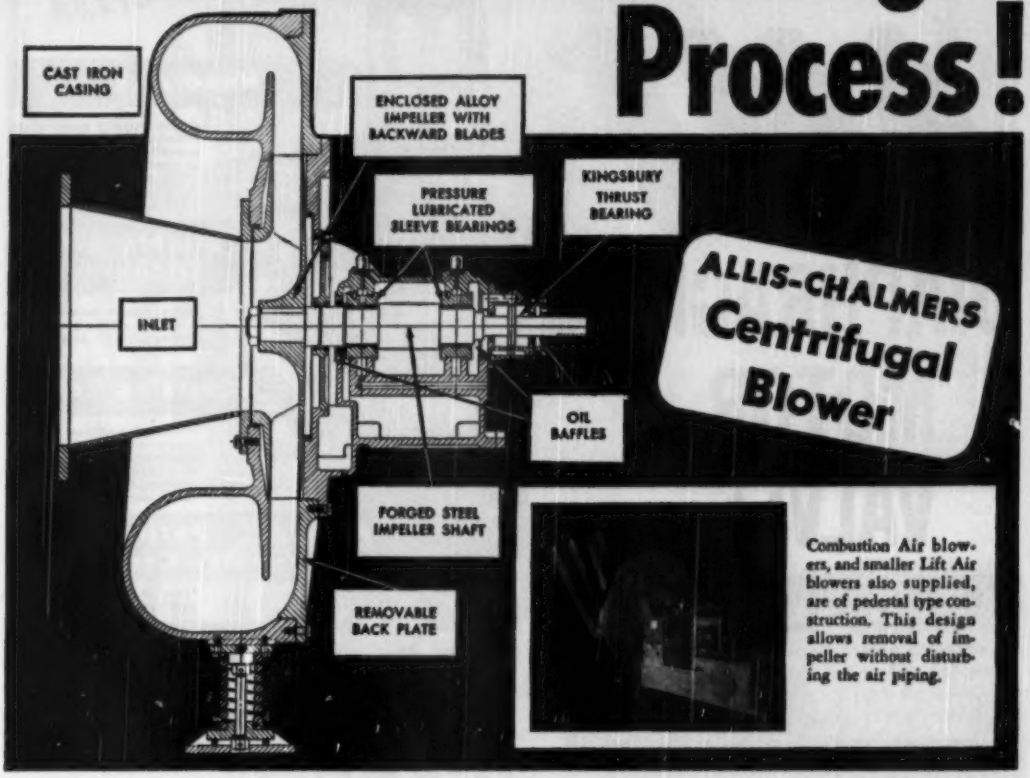
Tremendous savings in labor cost can be realized—PLUS other savings through lower tool cost and increased production. The operator is required only to fill the magazine and give supervisory attention. Thus a SINGLE operator can handle TWO OR THREE LANDIS Close Nipple Machines, depending on the pipe size.

New construction features contribute to longer life and more efficient operation. Special built-in safety devices guard against damage from jams and ease the supervisory job of the operator. *Write today for complete information and specifications.*

LANDIS *Machine* COMPANY · WAYNESBORO PENNSYLVANIA

Represented in the Domestic Oil Fields by: Colcord-Wright Machinery & Supply Co., St. Louis Mo.; C. J. Harter Machinery, Houston, Texas; Frederic-Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

Aids New Cracking Process!



Combustion Air blowers, and smaller Lift Air blowers also supplied, are of pedestal type construction. This design allows removal of impeller without disturbing the air piping.

ALLIS-CHALMERS IS HELPING THE PETROLEUM INDUSTRY in its trend to more efficient cracking methods. Large single stage centrifugal blowers are a vital part of new fluid catalytic cracking processes.

Cross-section drawing and photo above show some of the unusual features of a typical Allis-Chalmers blower used in one of these new refining processes. Rating of Combustion Air blower shown is 34,400 cfm, 3.5 lb G at 3630 rpm.

An important contribution to this blower's high efficiency is made by the special totally enclosed, backward flow, welded alloy steel impeller. The covered design makes the impeller independent of tolerance variations; the backward flow design gives it good pressure, volume and horsepower characteristics.

High strength and long life is assured by all welded alloy steel impeller construction and pressure lubricated sleeve and thrust bearings. Cast iron casing increases rigidity and decreases noise level.

For this kind of specialized design . . . or for standard high quality, thoroughly tested air and gas handling equipment . . . call your nearest A-C office.

A-3194

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MILWAUKEE, WIS.

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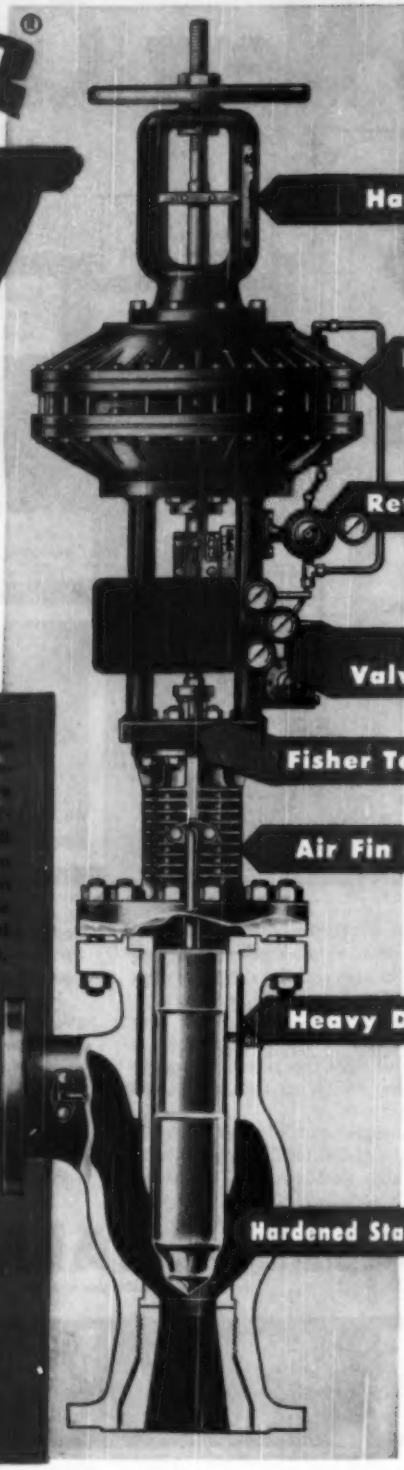
*AMT

DIAPHRAGM MOTOR VALVES



Hand Jack

For manually positioning inner valve. Allows manual operation for either opening or closing valve.

Double-Acting Diaphragm

Stem thrust power up to 5,000 lbs. at any point in its stroke without dead spot.

Reversing Relay

Performs additive or subtractive action to second diaphragm exactly opposite to pressure changes on primary diaphragm to allow full power thrust action.

Positrol Valve Controller

Insures accurate and fast positioning of inner valve.

Fisher Teflon Packing

Requires no lubrication.

Air Fin Construction

Heavy Duty Guiding

Assures positive inner valve alignment.

Hardened Stainless Steel Trim

Heavy duty guided inner valve for high pressure drop and tough corrosive or erosive service.

Built to Cut Maintenance

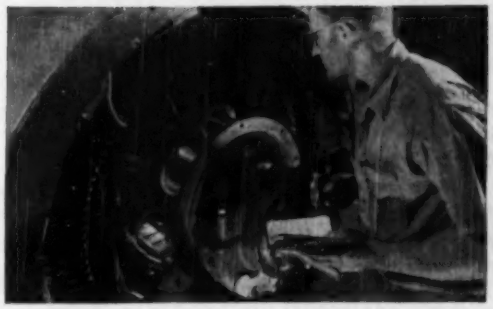
EASIER MAINTENANCE PROCEDURES and lower maintenance costs are important features of this brand new line of large motors. One man can perform all routine maintenance procedures, including opening up the motor for cleaning. Bearing surfaces are not exposed to abrasive grit and dirt during cleaning operations.

The appearance of this new line of large motors reflects the advanced design and fine workmanship that goes into their manufacture.

A well-braced, sturdy fabricated steel frame with cast-iron end brackets rigidly support and protect working parts. Ventilating openings are large to provide adequate cooling air at low velocities with resultant low sound level.

Wide Range of Sizes

These new design Allis-Chalmers drip-proof and splash-proof squirrel-cage induction motors are built in sizes from 60 hp at 300 rpm to 1500 hp at 1800 rpm. Ask your Allis-Chalmers representative to show you the details of this exceptional new motor or write for Bulletin 05R7542.



How's This for Accessibility

One man can remove the end brackets and air baffles and reach right inside motor with his vacuum cleaner or air hose. Bearing remains sealed against abrasive dirt throughout the cleaning operation.

Large air discharge openings with removable louvers allow plenty of room to get in with an electric drill for doweling and bolting the motor to the base. Plenty of room to reach up back of the stator core for cleaning.

A-3179

ALLIS-CHALMERS, 1062A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS

from lab . . . to pilot plant.

Agitate Fluids Better

with

Lightnin® Mixers

MIXCO® Engineered

Aiming for higher uniformity? Speedier fluid processing? Labor savings? Lower costs? Consult MIXCO for fluid agitation that *does what you want it to do.*

From a laboratory flask to a 5-million-gallon tank, MIXCO'S *specialized* agitation experience helps you plan every phase of the job for increased throughput . . . maximum efficiency . . . lowest power cost.

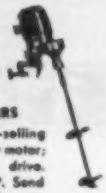
MIXCO engineers take the guesswork out of fluid agitation, with exclusive data that unerringly tells you the best way to agitate a batch or continuous process . . . tells you *in advance* what results you will get . . . and permits selection of the *right* equipment for the job.

Lightnin Mixers give you the widest possible choice of agitation variables, widest selection of materials and motors—using *standard components.* Lightnin Mixers are easier to service . . . easier to adapt to changing process conditions. They cut obsolescence and replacement costs to an irreducible minimum.

You can't lose with Lightnin, because process results (as well as equipment) are *guaranteed.* MIXCO takes *full responsibility* for success of the installation!

Write MIXCO engineers about your fluid agitation requirements today. Your inquiry will receive prompt, courteous attention.

A COMPLETE LINE . . . PLUS UNEXCELLED TECHNOLOGY



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World's largest-selling line. Electric or air motor; direct or gear drive. Sizes ⅛ to 3 HP. Send for Catalog B-75.

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For tanks up to 5 million gallons. Gear motor or V-belt drive; motorless types. Sizes 1 to 25 HP. Send for Catalog B-76.

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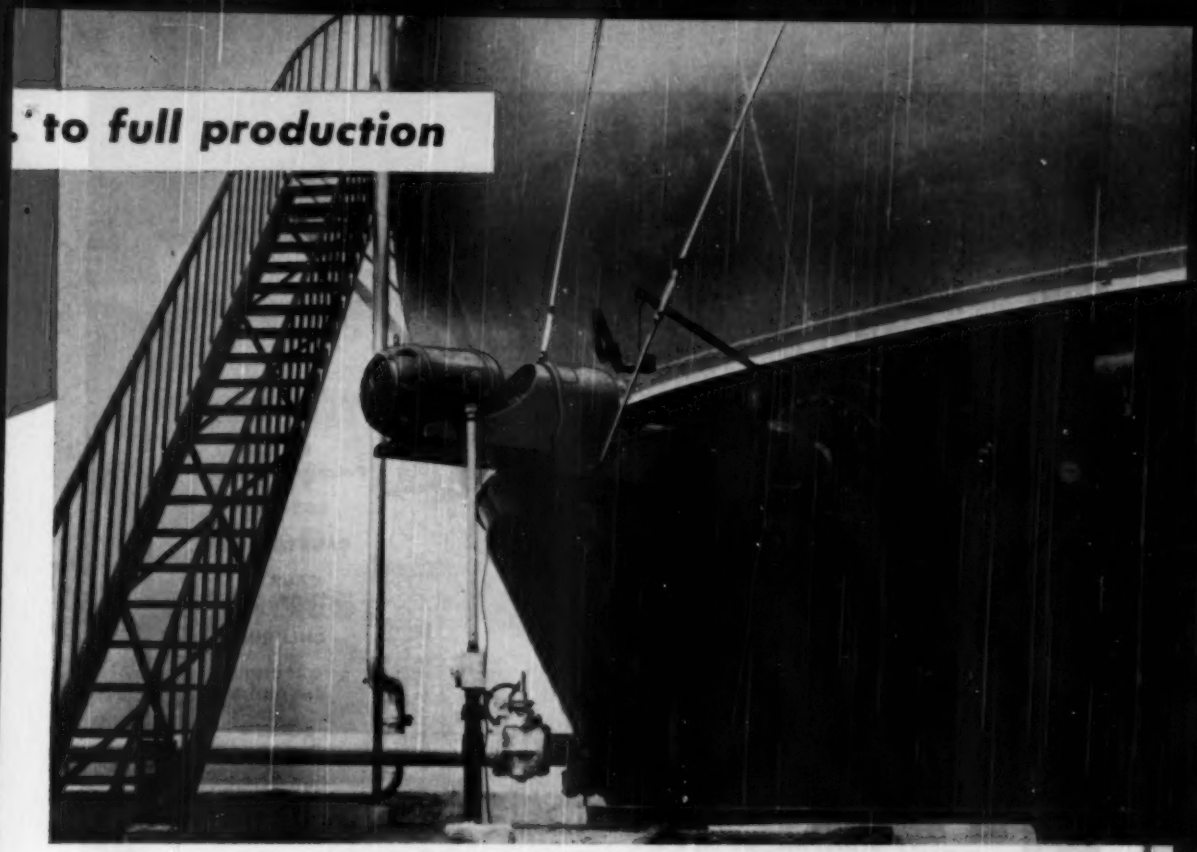
Turbine, propeller and paddle types. For open or closed tanks. Sixteen speeds available in new heavy duty drive. ¼ to 200 HP. Send for Catalogs B-89, B-78.



PROCESSES YOU CAN HANDLE BETTER, FASTER, CHEAPER WITH MIXCO ENGINEERED AGITATION AND *LIGHTNIN MIXERS:*

Gasoline blending
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For more information on Lightnin Mixers, see your copy of the Refinery Catalog—or use coupon to request specific bulletins.

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- ☐ B-89 Top Entering Mixers (Turbine and Paddle Type)
- ☐ DH-50 Laboratory Mixers
- ☐ B-52 Condensed Catalog showing complete line
- ☐ B-75 Portable Mixers (Electric and Air Driven)

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Company_____
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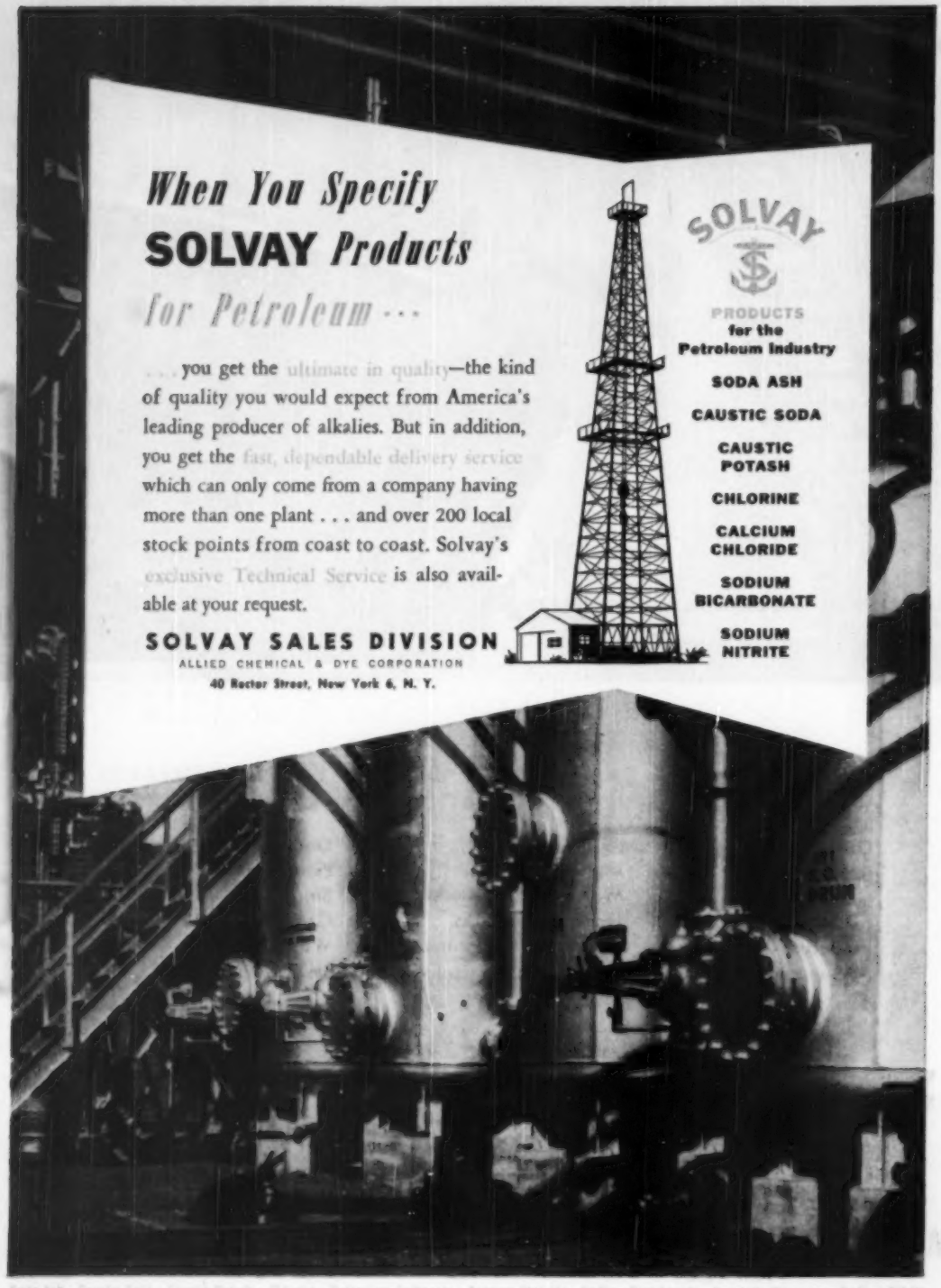
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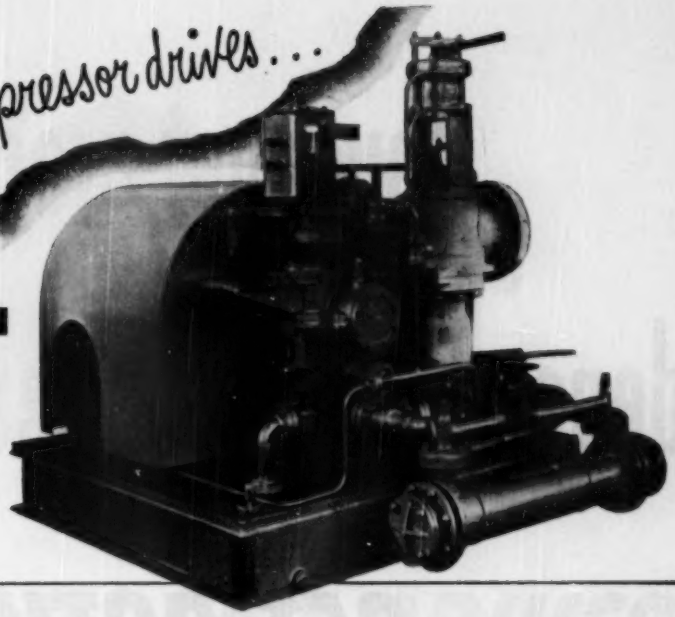
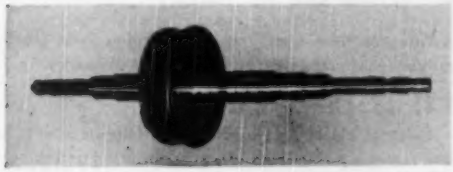
For your centrifugal compressor drives . . .

WORTHINGTON HIGH SPEED TURBINES!



Developing Up To 12,000 RPM, Worthington Turbines Are Outstanding For Driving Modern High Speed Centrifugal Compressors

Meeting the demand for steam turbine drivers for high speed machines, Worthington has developed a line of high speed turbines, many of which are already in operation. Smooth, steady driving power for blowers and centrifugal compressors is assured by a powerful oil relay governor — usually arranged for variable speed, either manually or through an outside controller.



Typical of the rugged construction of these turbines, the rotor illustrated is a single solid forging, with wheels and shaft integral. This rotor develops 3860 hp at 9150 rpm when supplied with steam at 600# G, 750° FFT and 185# G exhaust.

For Your Motor Driven Centrifugal Compressors

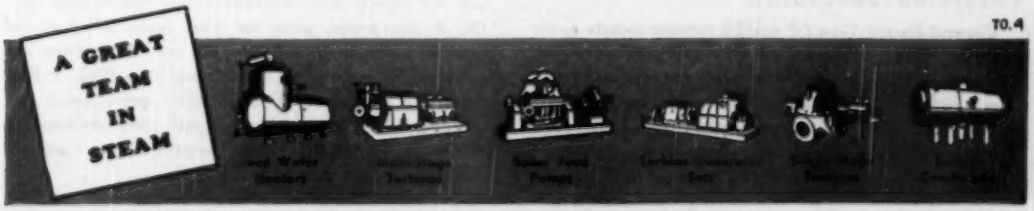
Worthington precision cut, high speed step-up gears increase motor speed to compressor speed. Gear teeth contours are carefully selected and machined for quiet operation and long life, while latest design high speed bearings reduce wear and assure trouble-free performance.

Get the facts on how these money-saving, always dependable turbines and gears prove *there's more worth in Worthington.* Write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.*

WORTHINGTON

STEAM TURBINES

TO.4



low-cost process heat
dependable low-speed power

GET BOTH with G-E

If your plant uses process steam, you may be able to improve over-all heat balance by driving low-speed equipment with General Electric geared turbines. Mechanical drive turbines act as reducing valves to drop boiler steam pressures down to utilization temperatures for process requirements. With turbines skimming off only a small portion of the steam's heat, mechanical power for driving fans, blowers, pumps and other low-speed apparatus is almost free.

Standard Type DP and DR turbines, combined with General Electric precision-type gears, are ideal for many such applications.

PRECISION GEARING

General Electric balanced-thrust gears are specifically designed for use with turbine drives. Smoothness and quietness of operation are the result of maintaining tooth contours and spacing to a high degree of accuracy.

Positive lubrication assures long life. Oil is delivered to the bearings from a gear-type pump driven by the pinion shaft. The gear mesh is spray-lubricated.

To meet a variety of application requirements, these gears are available in ratios from 1.5 to 10.3.

PRECISION GOVERNING

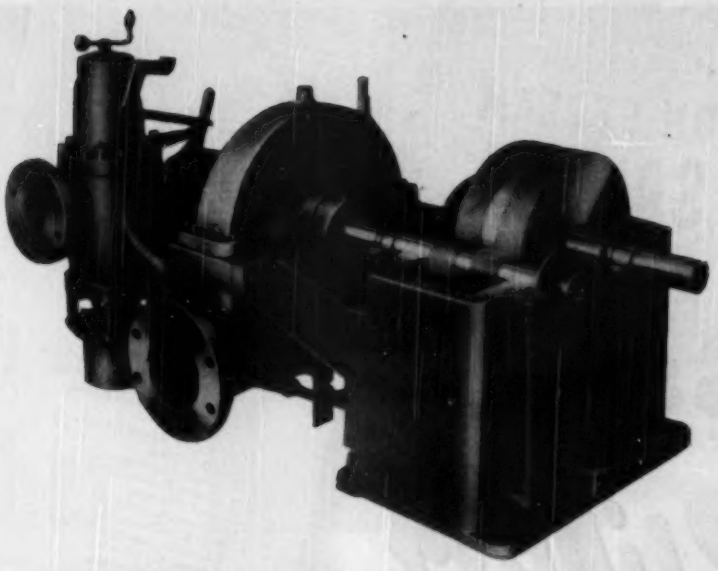
General Electric Type DP and DR turbines include extra features at no extra cost. The DP's hydraulic governing system provides a speed range of 30 per cent with 6 per cent regulation. The DR's oil-relayed governor offers speed ranges up to 5 to 1 with accuracy of ¼ of 1 per cent. Each turbine has its easily operated trip-throttle valve and governing valve combined in one compact unit. Rugged construction from quality materials makes these standard turbines outstanding for reliability and efficiency.

ONE INTEGRAL UNIT

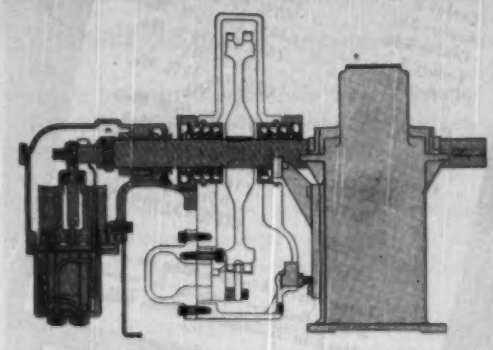
General Electric close-coupled turbine-gear sets have one common turbine and pinion shaft, with the turbine and gear casings solidly connected by a sturdy fabricated bracket. This construction results in a compact unit, does not require high-speed coupling.

Many standard parts are interchangeable with other turbine and turbine-gear drives.

Your nearby General Electric sales office will supply you with full details about mechanical-drive turbine-gear sets. Or, if you prefer, write for free copies of illustrated bulletins on these drives. The DP and DR turbines are described in bulletins GEA-4955 and GEA-5193. Bulletin GEA-5152 contains information about gears. Learn how installing these precision drives in your plant can save you money. Apparatus Department, General Electric Company, Schenectady 5, N. Y.



TURBINE-GEAR DRIVES

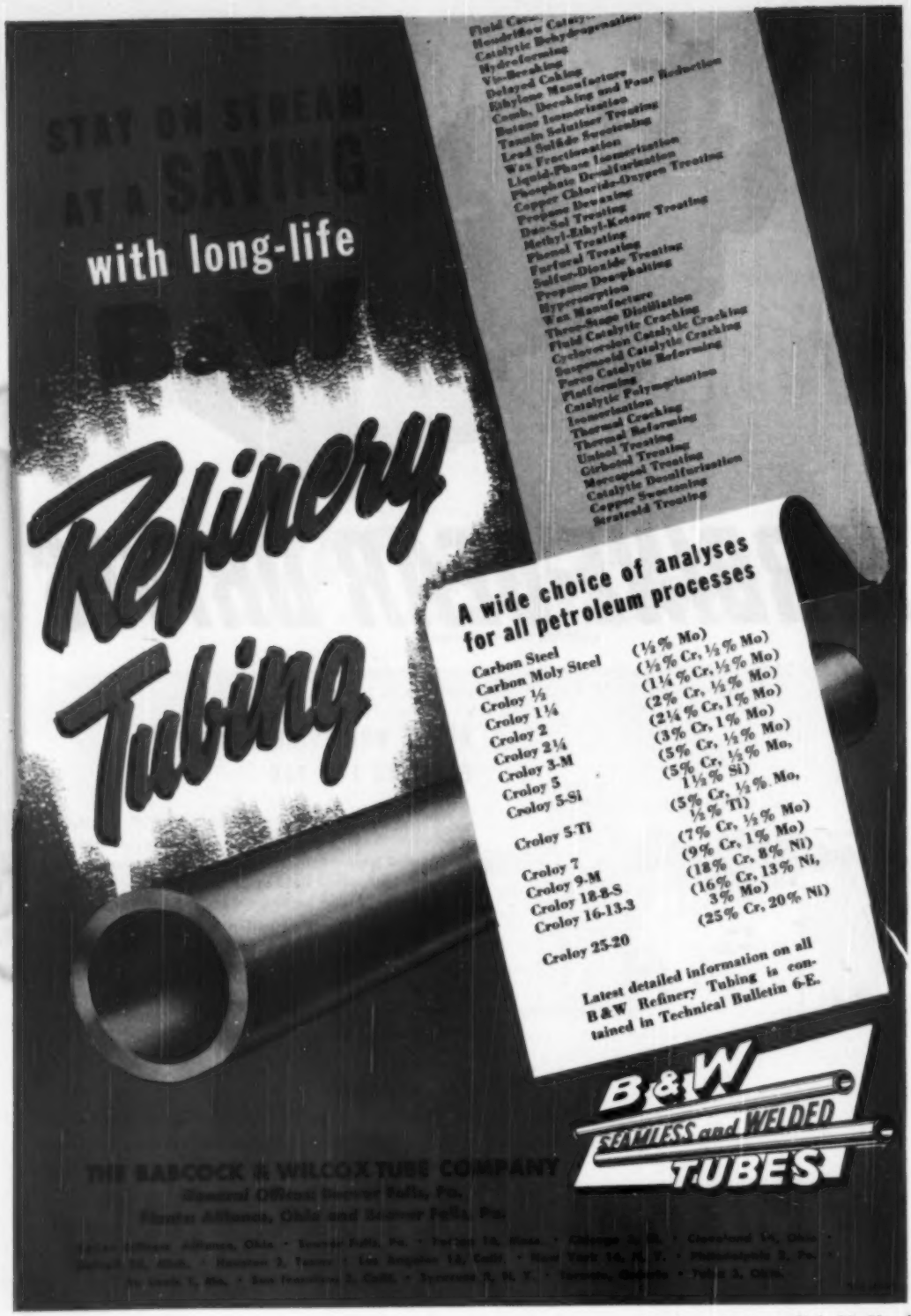


HERE'S WHAT STANDARDIZATION PROVIDES FOR YOU

This diagram shows how a standard DP turbine is close-coupled to a low-speed gear using an integral turbine and pinion shaft. All shaded turbine parts are interchangeable on all sizes of DP turbines. Thus, it is easy to stock spares, and maintenance costs are reduced. All individual turbine models and gear sets have standard shaft heights for easy installation or re-location in your plant. In addition, standardization cuts manufacturing expense, and the savings are passed on to you in the form of extra features usually found only on "special" turbine-gear drives.

GENERAL ELECTRIC

252-47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Carbon Steel (½% Mo)
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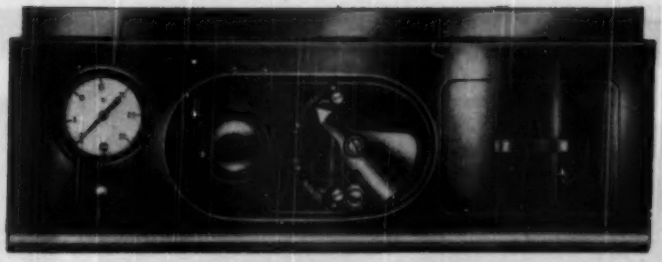
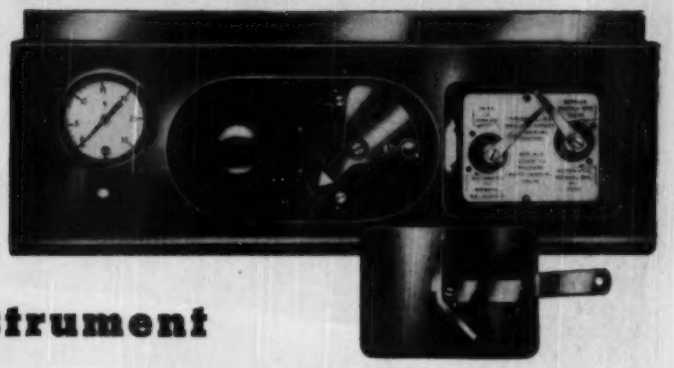
Croloy 1¼ (2% Cr, ½% Mo)
Croloy 2 (2¼% Cr, 1% Mo)
Croloy 2¼ (3% Cr, 1% Mo)
Croloy 3-M (5% Cr, ½% Mo)
Croloy 5 (5% Cr, ½% Mo, 1½% Si)
Croloy 5-Si (5% Cr, ½% Mo, ½% Ti)
Croloy 5-Ti (7% Cr, ½% Mo)
Croloy 7 (9% Cr, 1% Mo)
Croloy 9-M (18% Cr, 8% Ni)
Croloy 18-8-S (16% Cr, 13% Ni, 3% Mo)
Croloy 16-13-3 (25% Cr, 20% Ni)
Croloy 25-20
Latest detailed information on all B&W Refinery Tubing is contained in Technical Bulletin 6-E.
B&W SEAMLESS and WELDED TUBES
THE BABCOCK & WILCOX TUBE COMPANY



No other control instrument



has an external manual-automatic station as mistake-proof as this

EXCLUSIVE mechanical interlock prevents switching into wrong position

EXCLUSIVE "balancing" arrangement prevents "bumping" on changeover

Among the many features which have put the Bristol Series 500 Air-Operated Controller way out front is the unique External Manual-Automatic Station.

1. "Test" and "Service" positions are mechanically interlocked. Operator cannot, by mistake, go *through* "Manual" position into either "Test" or "Service."

2. Output pressures of the controller and the regulator on panel are measured by the *same* gauge. This enables operator to achieve exact *balance* before going from automatic to manual control or vice versa, thus eliminating the possibility of a "bump" to the process during changeover.

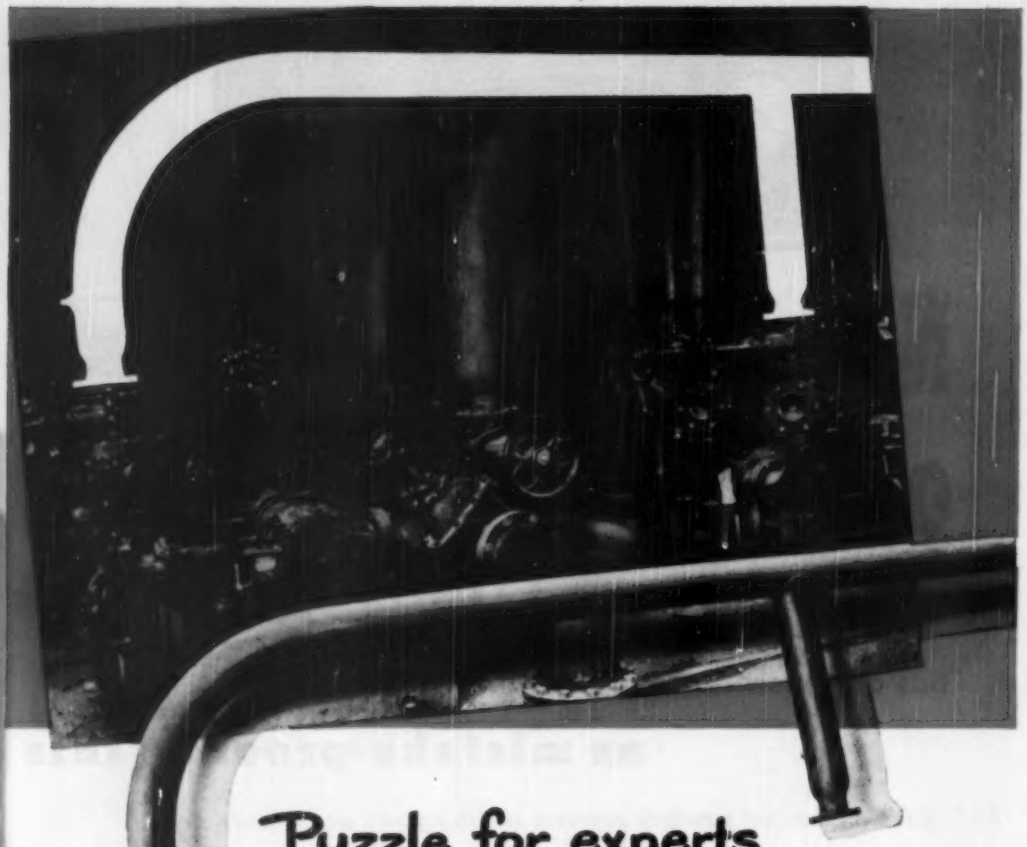
Bristol's External Manual-Automatic Station is an integral part of the controller installation . . . yet can be used independently for manually controlling the process *before* the controller is installed or *after* it has been removed for any reason.

Read what else Bristol Series 500 Controller gives you . . . calibrated control, single service adjustment, reset stops, etc. Write for new Bulletin A120 on Series 500 Air-Operated Controllers, THE BRISTOL COMPANY, 111 Bristol Road, Waterbury 20, Conn.

BRISTOL

Engineers process control for better products and profits

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



Puzzle for experts

There is no need for "cutting and trying" on the job to make a prefabricated piping sub-assembly fit perfectly. Prefabricated miles away to exact dimensions and specifications these pieces of piping are links in piping systems which may carry steam up to 2500 p.s.i. and 1050°F.

Grinnell integrates the many factors in this complex, highly technical assignment in one organization of specialists. Major economies result from this single responsibility which includes interpretative engineering, metallurgical research, compliance with code requirements, manufacturing drawings and specifications, production schedules, purchase of materials, specialized facilities, skilled personnel, control of quality and rigid inspection.

You'll find it to your own best interests to draw upon Grinnell's century-long, specialized experience in power, process and industrial piping.

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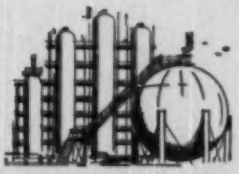
Enduro STAINLESS STEEL

THRIFTY METAL OF 10,000 USES



Bubble Caps and Trays are "naturals" for rugged, easy-to-work and easy-to-maintain stainless steel. So, too, are vapor risers, still linings, deck plates, hot oil lines, cracking stills, expansion joints, sludge tanks and swing lines.

BLOCKS BUBBLE TROUBLE

Not only does ENDURO, with its high resistance to coking, rust and corrosion, reduce bubble trouble to a minimum. Because of its high strength-to-weight ratio and its ease of fabrication, more teeth or slots per cap are possible than with less rugged or harder-to-work metals.

The inevitable result is more intimate liquor-vapor mixture on the tray – and sharper fractionation.

Other *plus* factors of ENDURO–all vital to refining–are the maintenance of its high strength through blistering heat and sub-zero cold – its positive resistance to most acids, gases and superheated steam – and its smooth, pore-free, easy-to-clean surface.

These add up to minimum maintenance, long equipment life, maximum "on-stream" performance, high productivity and low cost. ENDURO pays its way.

Why not check with your equipment supply source – today?

✓ **CHECK ALL 12 ADVANTAGES: Rust- and Corrosion-Resistance • Heat-Resistance • High Melting Point • Low Coefficient of Expansion • High Strength • Good Dimensional Stability • No Metallic Contamination • Easy to Clean • Easy to Fabricate • Eye Appeal • Long Life • Low End Cost • *What more can be desired in a material?***

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C. H. Wheeler
FAR OUTLASTS ITS DEPRECIATION PERIOD
Any water cooling tower "should" do all right for a few years, but after 5 or 10 years' service, users really appreciate the heavier, high quality materials and "tailor-made" construction of C. H. Wheeler. They still look and work "good-as-new" and continue to remain so for years and years, even where the installation location presents great weather extremes in summer and winter. Further, they are guaranteed to withstand hurricane winds up to 100 miles per hour. A good typical example of "5 year appreciation," and a repeat order, is shown in the photograph below, the latest installation, of course, being the new C. H. Wheeler "Funnel Top" Tower, which streamlines the flow of air from the water cooling zone to the Induced Draft Fans at the top of the tower. In 1955 or '60, you'll be glad, if you specify C. H. Wheeler Cooling Towers today. Write for Catalog No. 145.
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REPRESENTATIVES IN MOST PRINCIPAL CITIES
INSTALLED 1948
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a new service to the State of California and the Territory of Hawaii by a name known to western oil producers and refiners since the turn of the century.

HAMMOND VAPOR-LIFT
The Vapor-Lift Tank has full liquid storage capacity and in addition the roof raises itself everytime the vapor pressure increases and lowers itself as the vapors diminish.

HAMMOND DIALIFT TANKS
Variable vapor storage capacity obtained through raising and lowering action of Dialift membrane induced by vapor pressure.

LACY MANUFACTURING CO.

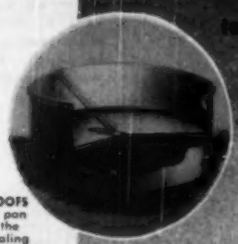
has been licensed by

HAMMOND IRON WORKS

to fabricate their patented

vapor recovery and

conservation storage tanks



HAMMOND FLOATING ROOFS
Of double deck, pontoon or pan types. All designs employ the Hammond Cantilever sealing mechanism with secondary seal for additional protection—at no extra cost.

Now, Lacy Manufacturing Company makes available, to California and Hawaii, the specially designed tanks that bear the famous name Hammond. Fabricated and erected in these regions by a firm whose first steel tank was built better than half-a-century ago and whose dependability is proven—Lacy Manufacturing Company.

Lacy Manufacturing Co.

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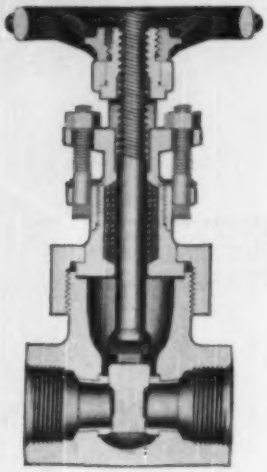
Big help to any standardization plan ...the complete CRANE line



No. 3602X, 600-Pound Small Steel Gate for oil or oil vapor up to 1100° F. Exalloy to Exalloy seating. Sizes: ¼ to 2-inch. Screwed or welding ends.

MODERATELY PRICED SMALL STEEL VALVES

Why moderately priced? Because of Crane Co.'s better facilities for *quality* mass production. Designed to withstand tough services, Crane Small Steel Gates provide extra strength and safety under piping and pressure strains, and extreme temperature variations.

These rugged, compact valves are easy to service... easy to operate. Husky union bonnet ring with long thread engagement pulls up easily, stays tight, protects against distortion when valve is opened. T-head disc-stem connection gives flexibility for smooth operation. Fully guided solid wedge disc cannot get out of line, drag on seating surfaces, or jam in body.

Little routine maintenance required. Deep stuffing box with one-piece gland and gland flange assures tight stem seal. Outside screw and yoke construction keeps stem threads out of contact with line fluids, simplifies lubrication. See your No. 49 Crane Catalog, or write for Circular AD-1741.

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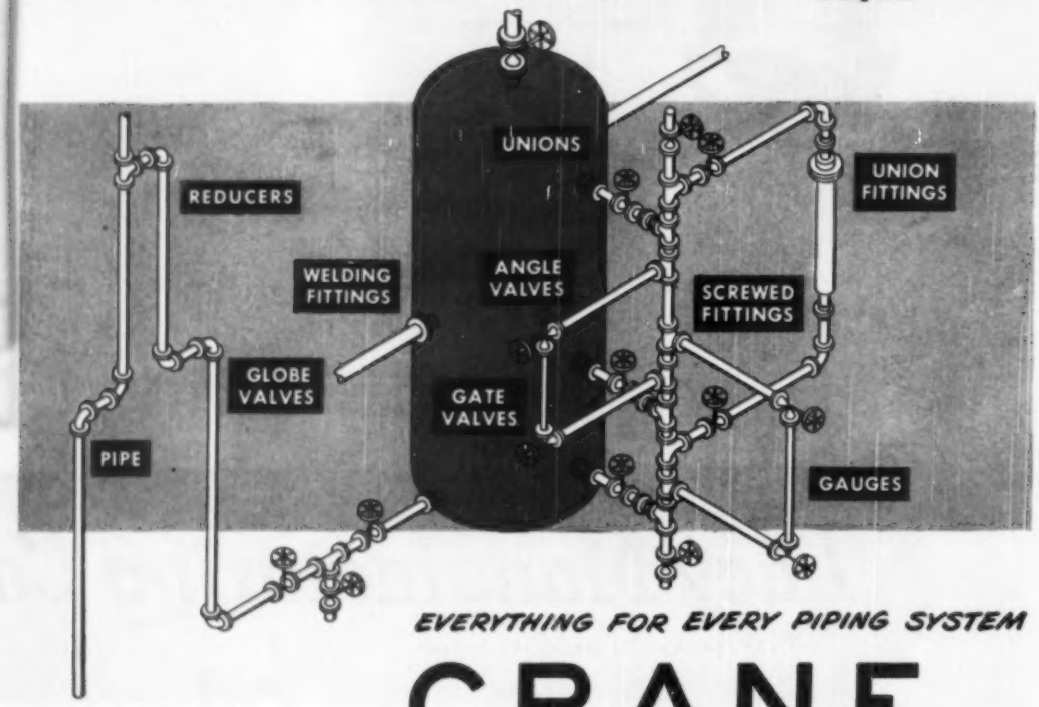

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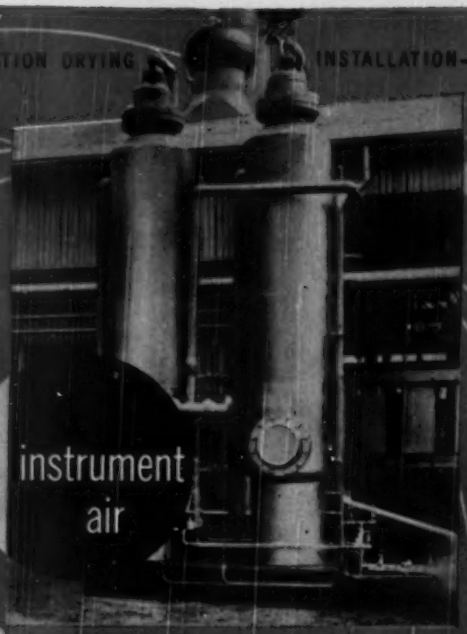

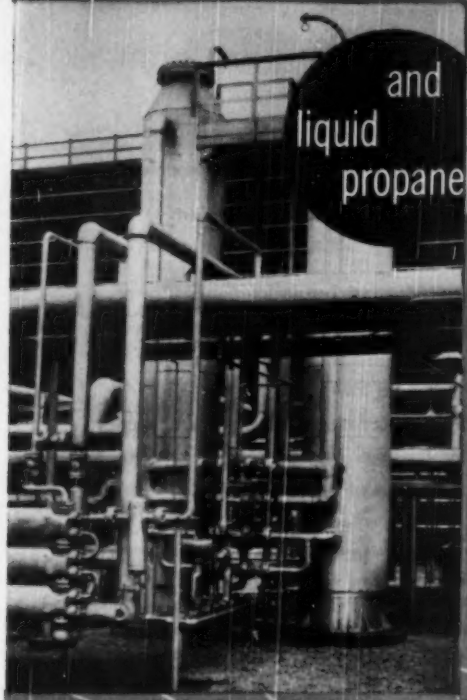

and liquid propane

at Warren's Gladewater, Texas, plant

The Warren Petroleum Corporation designed these dehydration units for their Gladewater, Texas, Plant. Approximately 70,000 gallons of propane are passed through the liquid dehydration unit daily, while the air-drying unit provides Warren with clean, DRY air—a guard against corrosion, rusty lines and clogged valves. ALCOA *Activated* Alumina is the desiccant used in these units, drying *both* liquid and air to *minus* 40°F.

ALCOA *Activated* Alumina is a thoroughly reliable, non-corrosive drying agent that will not change its form or properties—will not swell, soften or disintegrate. It has high resistance to shock, abrasion and erosion, and is non-toxic and inert to most gases. Furthermore, ALCOA *Activated* Alumina dries air and liquid and gaseous hydrocarbons to lower dew points than any other commercial adsorbent.

If you are looking for a stable, reliable, economical agent for drying gases, vapors or organic liquids, our booklet "Activated Alumina—Its Properties and Uses" will give you *all* the facts. You can get it free by writing to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 617L Gulf Building, Pittsburgh 19, Pennsylvania.

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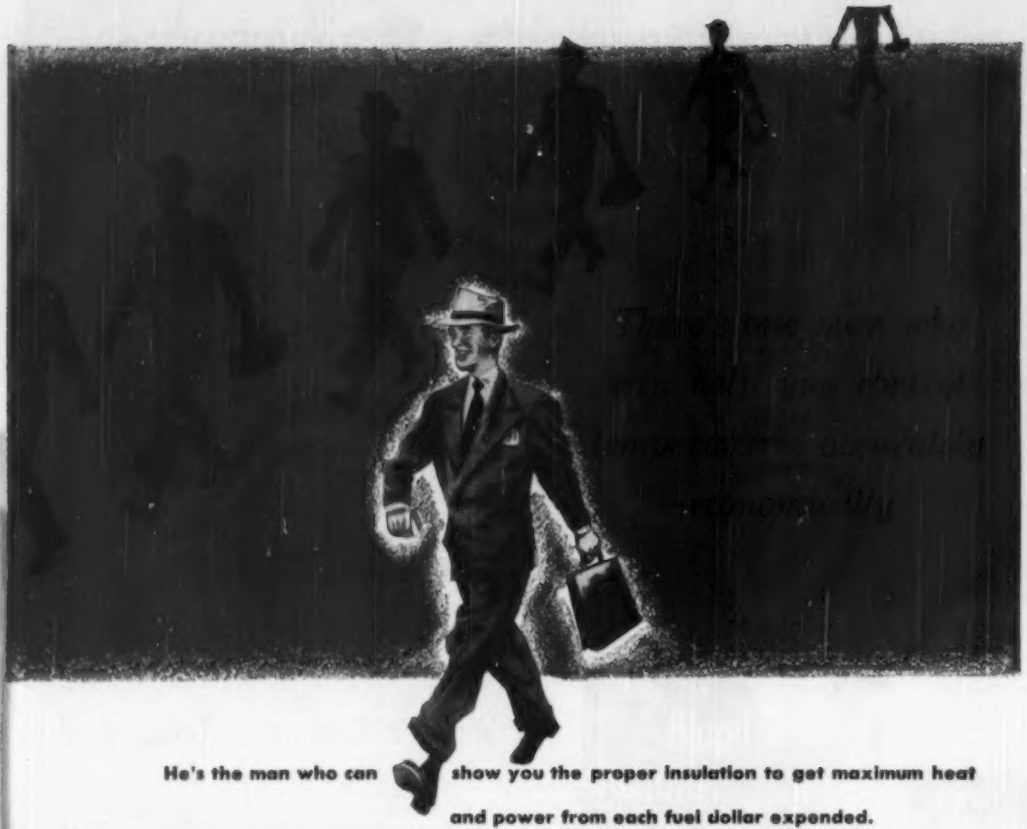
ALCOA ALUMINAS and FLUORIDES



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Super "66" is all-purpose, rust-inhibitive, extremely adhesive insulating cement. "Springy ball" pellets don't collapse after application . . . give great coverage, retain their thermal efficiency. 100 lbs. covers 65 sq. ft.—1 inch thick! Easily applied with trowel, over flat and irregular surfaces. Efficient for temperatures up to 1800°F. Reclaimable when used on equipment whose temperatures do not exceed 1200°F.!

An Eagle-Picher Industrial Insulation distributor or representative can help you reduce operating expenses because he has available a wide line of insulation products—for high and low temperatures—scientifically designed for maximum thermal efficiency, and practical application. Why not let him give you more information about some of the products listed here?

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Insulating Felts • Supertemp Blocks • Blankets
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Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

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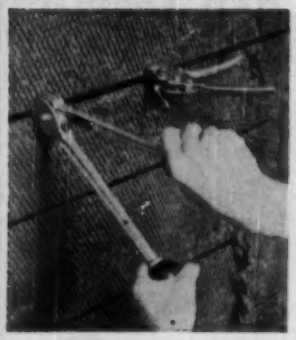
Since 1843

Get maximum fuel savings and exact temperature control with these versatile, efficient insulations

For a completely effective, low-cost insulation combination, you can't beat the teamwork of Eagle-Picher Mineral Wool Blankets, Supertemp Blocks, Super "66" Insulating Cement, No. 106 Fireproofing Cement and Insulseal. They work effectively to give your equipment highest possible thermal efficiency . . . cut operating costs by saving maximum amount of fuel . . . and help to provide perfect, precise control over temperatures.

EAGLE-PICHER FIREPROOFING CEMENT

Mixed with water to form a stiff plastic mix for easy application on ribbed lath. Recommended for fireproofing structural steel columns, steel tank supports, skirts and equipment bases. Has high dry coverage of approximately 30 sq. ft. 1 inch thick per 100 pounds. Adds fire protection, patented rust-inhibitor resists corrosion. Tested by Underwriters' Laboratories, Inc.



EAGLE-PICHER MINERAL WOOL BLANKETS

These blankets satisfy the need for a convenient method of quickly and efficiently insulating flat or curved surfaces on larger types of heated equipment. Mineral wool is felted and secured between flexible metal fabric. Outstanding physical and chemical stability enables Eagle-Picher Blankets to resist water, steam, corrosive fumes and normal vibration.

EAGLE-PICHER SUPERTEMP BLOCKS

Eagle-Picher Supertemp Blocks are lightweight (approximately 16 lbs. per cu. ft.). Can be cut easily with knife or saw to fit off-shaped areas . . . they fit snugly over minor irregularities. They're strong and have high refractory value. Withstand temperatures up to 1700° F. Conductivity at 512° F. approximately 0.43 . . . all standard sizes, from 3" x 18" to 12" x 36" . . . in thicknesses from 1" to 4".

EAGLE-PICHER INSULSEAL

A tough, weatherproof, protective coating for insulation. For temperatures up to 450° F. Applied as a plastic, its smooth troweling qualities assure uniform coverage, proper thickness. It protects insulation from air infiltration, fumes, rain, snow, vibration, punctures, and withstands severe service, indoors or out. Dries to a smooth, rich black, has a neat appearance on hot or cold surfaces . . . may be washed or painted.

THE EAGLE-PICHER COMPANY General Offices: Cincinnati (1), Ohio

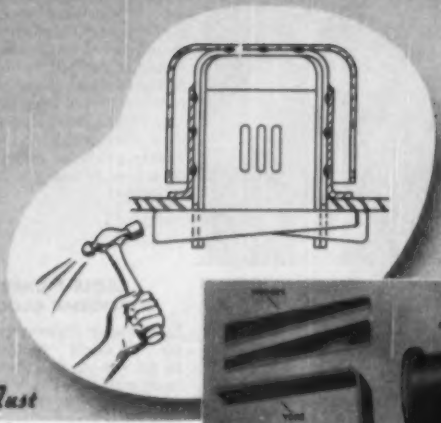
Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

EAGLE EP PICHER *Since 1843*

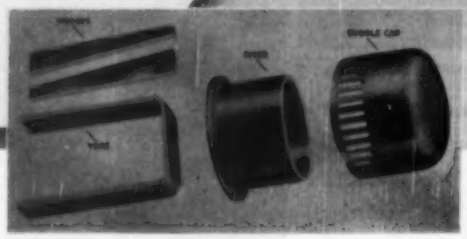
CUT TOWER CLEANOUT TIME

with *Le Jons*

BUBBLE CAP ASSEMBLY



Just Hammer Wedges In or Out



The new Le Jons bubble cap assembly is also showing impressive savings in tray construction cost. The cap, riser and yoke, shown in the exploded view, come securely welded together. To install just hammer in wedges and bend over slightly to lock. No bolts or nuts. No costly flaring or welding of risers. Assemblies furnished in any workable metal, style and size of cap. Let us send you full details.

Offering unprecedented simplicity, the new Le Jons method of assembling bubble caps is clearly effecting substantial maintenance savings. For instance, installation records show that cleanout and inspection time has been materially shortened; the bubble caps can be removed by merely hammering out the wedges. It has been repeatedly demonstrated that the simplicity and tightness of the assembly, together with its automatic alignment of caps, maintain operating efficiency in the tower, and thus lessen down time.

PSC EQUIPMENT IS "ALLOY RIGHT"

Over 200 STANDARD STYLES of Caps and Risers, without Die Cost

With the dies on hand, we not only make prompt delivery but also save many customers the cost of dies. Special caps promptly designed. Send blue prints.

Send for

BUBBLE CAP BULLETIN 21

The largest compilation of engineering data on bubble caps in printed form. Also drawings for use in determining methods of tray assembly. BULLETIN 31 describes Le Jons assembly.

LICENSED UNDER PATENT NO. 2430862

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of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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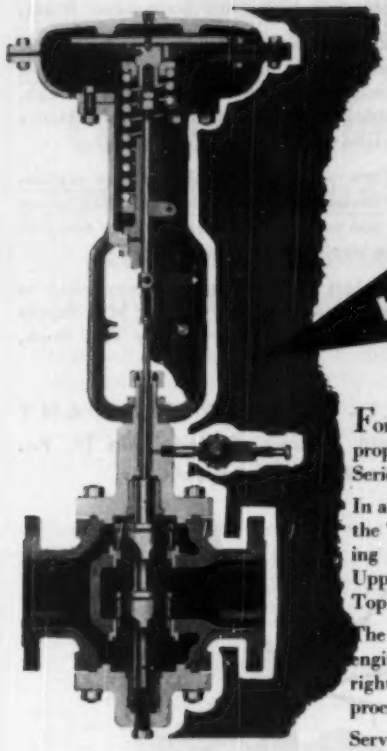
• There are many diaphragm control valves...but



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Troubled with outdoor steam traps freezing? Solve the problem the way Thermoid did at their Trenton, N. J., plant.

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Condensate does not accumulate in Yarway Impulse Traps. The only moving part—a little valve—floats on the load. It discharges condensate as it comes through, instead of waiting for a quantity to accumulate. Hence —nothing to freeze.

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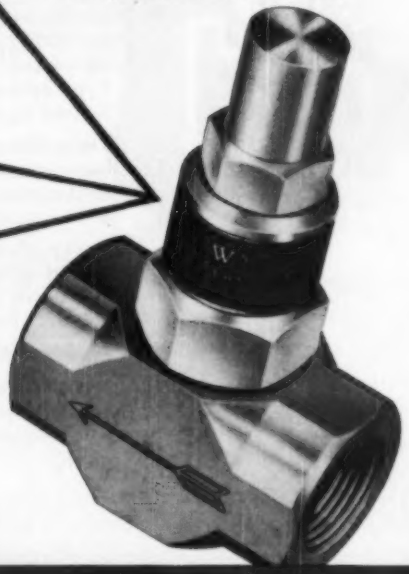
Often it costs less to install new Yarways than to repair old type traps. See your nearest Mill Supply Dealer. For his name, and free Yarway Trap Book, write . . .

YARNALL-WARING COMPANY
128 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities

Yarway Traps beat the worst weather in this installation at Thermoid's Trenton plant.



YARWAY IMPULSE STEAM TRAP

Counsel Offered

ON METAL PROBLEMS

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FABRICATION • PERFORMANCE

Experienced counsel on problems relating to ferrous and non-ferrous alloys containing nickel is yours for the asking . . . write, wire or phone the INCO Technical Field Section or Stock and Service Center nearest to your plant.

"INCO" TECHNICAL SECTIONS

Consultation on technical problems relating to alloys containing nickel is invited. Consult the nearest Technical Field Section of INCO Development and Research Division listed below:

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25 King Street, West,
Toronto 1, Ont.
Tel. Elgin 7471

CENTRAL ATLANTIC COAST SECTION
67 Wall Street,
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CHICAGO SECTION
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Tel. Franklin 2-4030

CINCINNATI SECTION
Carew Tower,
Cincinnati 2, Ohio
Tel. Parkway 1431

DETROIT SECTION
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The following are sources of supply for primary nickel for alloying purposes. Through casting specialists, they are prepared to offer technical service on the production of ferrous and non-ferrous castings containing nickel.

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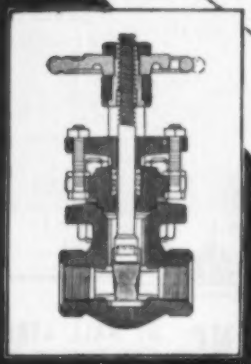
150-800 POUND

GATE VALVES

SIZES ¼" TO 2"



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CARBON STEEL | 800 Pounds @ 750° F.
1500 Pounds Cold Non-Shock

For 150-800 pounds service • Round Bolted Bonnet • Bolted Gland • Gasket or Ground Joint • Outside Screw and Yoke • Renewable Seat Rings • Solid Wedge — Slotted Type • Rising Stem 11½-13% Chrome Stainless Steel Trimmings • Sizes ¼" to 2" inclusive.

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that can stand the acid test

Lead-lined or lead-covered equipment for handling corrosive chemicals has maximum life when it's "Homogeneous" equipment made by National Lead.

In "Homogeneous" equipment, the lead lining is inseparably *bonded* (not *loose-lined*) to the metal of which the apparatus is constructed. The bonding is accomplished by applying the lead directly to this metal without use of tin or tin-lead solders.

The "Homogeneous" process of bonding gives you positive assurance that the lead will not creep, buckle, or lose its grip. Despite shock, vibration, vacuum, pressure or high temperatures, that bond will hold. In fact, the bond will not be broken unless heat is applied closely approaching the melting point of lead itself (620°F.).

All of National Lead's "Homogeneous" Lead-lined or Lead-covered Equipment is individually fabricated to your specifications.

Our Engineering Department will be glad to discuss the value of "Homogeneous" lead-lined or lead-covered protection for acid cars, trailer tanks, acid columns, agitators, autoclaves, digesters, heat exchangers, vacuum tanks, storage tanks, propellers, heating and cooling coils. Consult with these specialists whenever you need processing equipment that's built to stand the acid test.

...look to the Leader in Lead

...in everything from lead pipe...valves...sheet...and lead-lined or lead-covered equipment...to complete acid recovery plants.

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Dutch Boy PRODUCTS

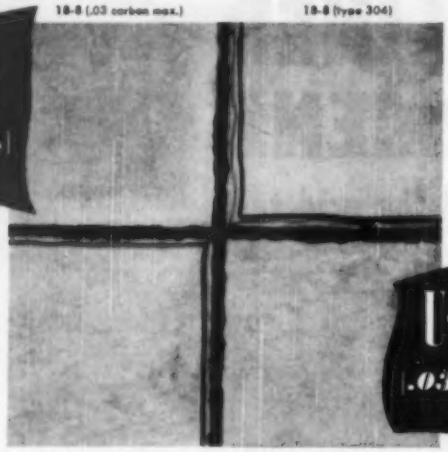
Reg. U. S. Pat. Off.

Two new extra-low carbon

U·S·S Stainless Steels

give high corrosion resistance after welding

U·S·S 18-8
[.03 carbon max.]



U·S·S 18-8Mo
[.03 carbon max.]

This panel, composed of specimens of the four grades indicated, illustrates dramatically how low carbon grades resist corrosion after welding. The panel was exposed for 6 hours to a 10% HNO_3, 3% HF solution at 80°C. Neither of the low carbon specimens shows evidence of deterioration, while the standard 18–8 (type 304) grade is completely severed at the critical weld zone and the standard 18-8Mo (type 316) specimen is severely attacked at this point.

If you need a grade of Stainless Steel that must undergo exposure to exceptionally severe corrosive conditions after welding or hot forming, you'll find real savings in these two new grades of U·S·S Stainless Steel which contain a maximum of 0.03% carbon.

During exposure to sensitizing temperatures—800° to 1600°F.—some of the chromium in ordinary grades of Stainless combines with carbon to form chromium carbides, thus reducing corrosion resistance. Heretofore, fabricators have had to combat this by annealing the product or by the use of steel containing such stabilizing elements as columbium or titanium—both expensive operations.

Development of two new U·S·S Stainless Steels—U·S·S 18-8 [.03 carbon max.] and U·S·S 18-8 Mo [.03 carbon max.]—now makes the inconvenience of special treatment or the extra cost of stabilized grades in many applications unnecessary. In these new grades, the carbon content has been drastically reduced, practically eliminating the problem of carbide precipitation with resultant intergranular corrosion.

Corrosion tests of welded joints have indicated that these new grades give resistance to intergranular corrosion adjacent to welds equal to the more expensive stabilized grades and far in excess of ordinary grades.

By replacing stabilized grades with low carbon grades, you can realize savings in material costs up to 10%. In many cases, stress-relieving of welded vessels can be accomplished at substantially lower temperatures.

Get all the facts on these two new U·S·S Stainless Steels by writing for a copy of our booklet. Send your request to United States Steel Corporation Subsidiaries, 2199 Carnegie Building, Pittsburgh 30, Pa.

Where to use these low-cost, low-carbon Stainless grades

Welded tubing
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Drawn shapes for welded assemblies
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Sulfite digesters
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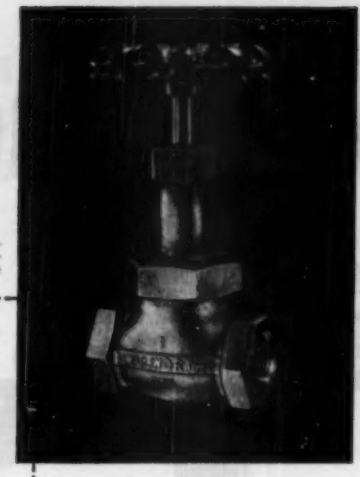
UNITED STATES STEEL

IDENTIFICATION DISC: An aluminum marking plate on all Walworth No. 225P's facilitates inventory control and makes reordering quick and positive.



take a good look at the Walworth "500 Brinell" no. 225P Globe

NEWLY DESIGNED HANDWHEEL: Patented air-cooled, finger-fit handwheel affords sure grip even with greasy gloves.

– the Toughest Bronze Valve Your Money Can Buy

The stainless steel, corrosion resistant seats and discs are heat treated to a hardness of 500 Brinell – hard enough to scratch glass and crush nails! The valve can be closed on sand, slag, and pipe scale without injury to the seating surfaces. "Wire drawing" is practically eliminated. All parts are accurately machined and gaged. Years of tight, positive shut-off are assured.

Available in both globe and angle types (angle type: No. 227P) in sizes ¼" to 2", this quality valve is recommended for 350 lbs. W.S.P. at 550 F, and 1000 lbs. non-shock service on cold water, oil, gas, or air.

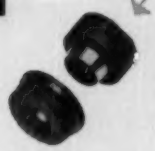
For full data on this long-life, economical Walworth Bronze Valve, see your local Walworth distributor, or write for Circular.

IMPROVED PACKING: Molded packing of lubricated asbestos reinforced with copper wire. Suitable for practically every service. Valves can be repacked under pressure when fully opened.

note these 7 Great Features

HEXAGONAL UNION BONNET CONNECTION, DEEP STUFFING BOX AND RUGGED STUFFING NUT: Union bonnet connection eliminates any chance of distortion or leakage even though valve is repeatedly taken apart and reassembled.

OVERSIZE STEM: The high-tensile strength silicon-bronze stem assures long life and protection against wear.



SEATS AND DISCS: Plug type seats and discs of stainless steel, heat-treated to 500 Brinell hardness and machined simultaneously to a mirror-like finish, with accurate tapers assures tight positive shut-off with minimum handwheel effort.

EXTRA STRONG BODY: Made of Composition M (ASTM B61) bronze. Thick walls and rugged hexes provide a high safety factor. Valves undergo hydrostatic shell test of 1,000 psi.

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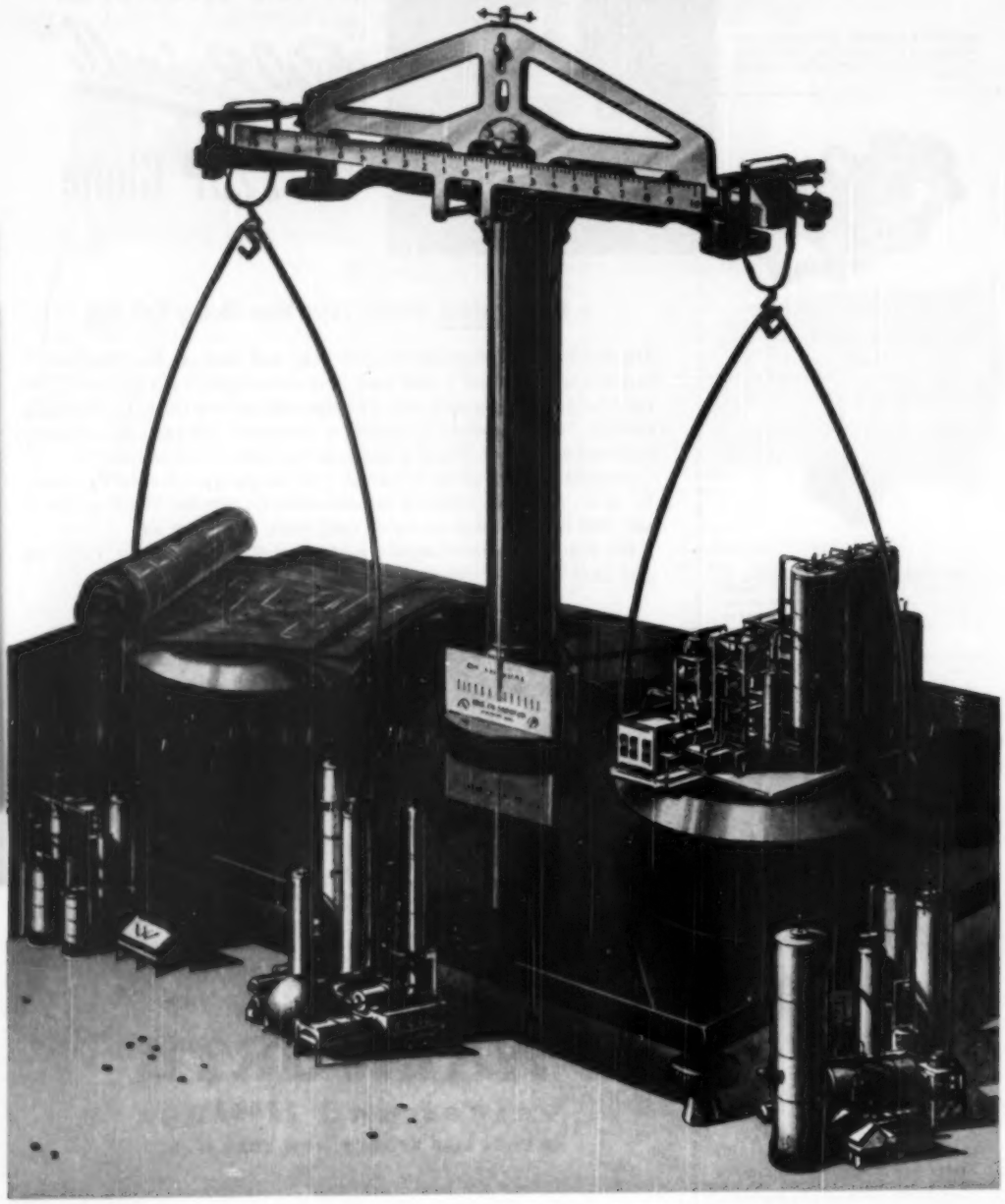

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Before considering plant expansion or new construction, manufacturers in the process industries must have assurance today that the final cost of a new plant will bear reasonable relationship to the initial appropriation.

Badger is able to give valuable assistance in making rational and adequate estimates of cost, based on current experience in the design and construction of similar plants in all parts of the world.

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Powell makes valves specifically adapted to YOUR industry. The Complete Powell Line includes Globe, Angle, Gate, Check, "Y", Non-return, Relief and Flush Bottom Tank Valves, in Bronze, Iron, Steel and the widest range of Corrosion-Resistant metals and alloys ever used in valves.
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IN SINGLE DECK ROOFS
IN 20 YEARS

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Patented design combines the stability and the vapor-saving, corrosion-resistant features of the double-deck floating roof with the more economical aspects of the conventional pan-type roof.

NEW FEATURES FOR IMPROVED PETROLEUM STORAGE

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- Requires *less steel* to build.
- Positive drainage at center due to increasing slope.
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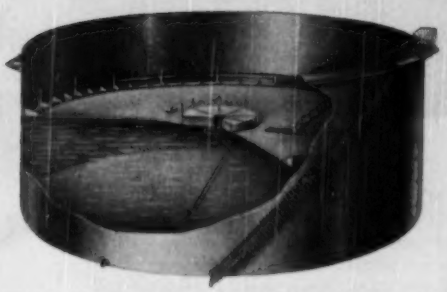
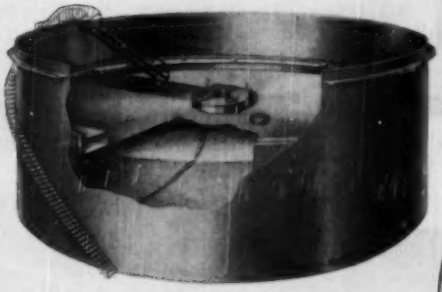
- Proved construction—tested in actual installations.

Send for New Book on Graver Center-Weighted Floating Roofs.



PAN-TYPE Center-Weighted Floating Roof . . . for southern climates where rain is the only weather problem.



PONTOON Center-Weighted Floating Roof . . . for northern climates involving snow, ice and rain.

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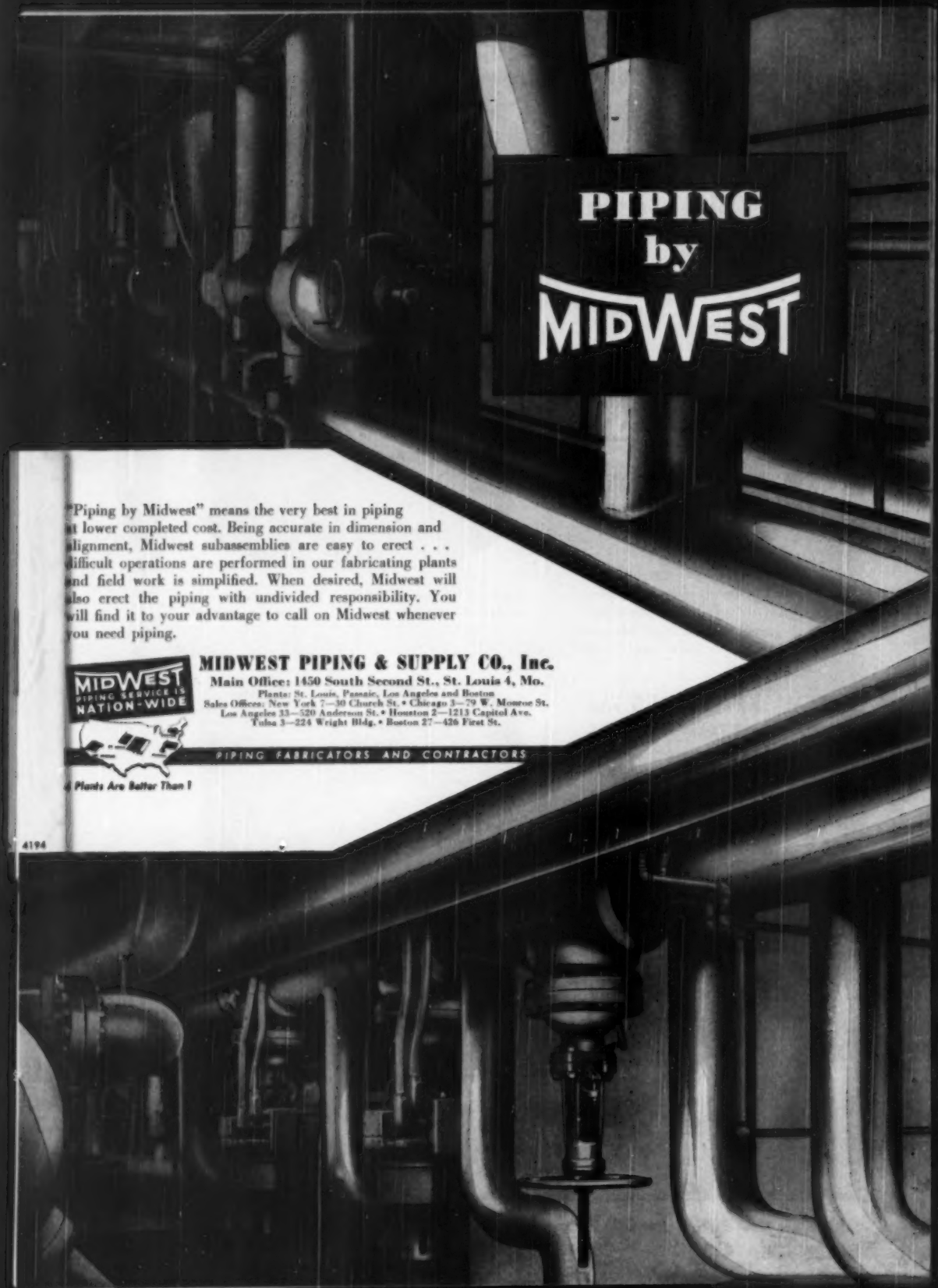

"Piping by Midwest" means the very best in piping at lower completed cost. Being accurate in dimension and alignment, Midwest subassemblies are easy to erect . . . difficult operations are performed in our fabricating plants and field work is simplified. When desired, Midwest will also erect the piping with undivided responsibility. You will find it to your advantage to call on Midwest whenever you need piping.

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. . . single-layer application saves money

When you can insulate a pipe efficiently with only one layer of covering, you save money. The range of thicknesses in which Unibestos Pipe Insulations are made permits the economies of single-layer application. Also a distinct saving in warehousing is made possible because fewer sizes of insulation are required in stock for maintenance work. But range of insulation thicknesses for single-layer application is only one of the many features of these 2 great pipe insulations—UNIBESTOS No. 750 and No. 1200. Write today for catalog giving complete information.*

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After manufacturing and delivery — work for you has just begun. Key Field Engineers live with your fittings until retirement. The Key Company offers supervision on installation — maintenance assistance — and is the only manufacturer in the field to encourage and sponsor reconditioning service in the interest of the oil refineries.

Write, Wire or Phone for Complete Details

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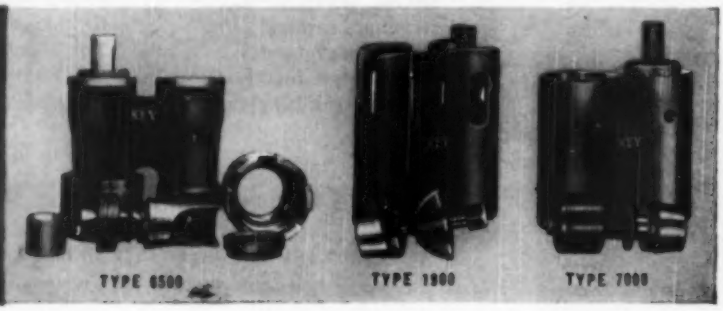
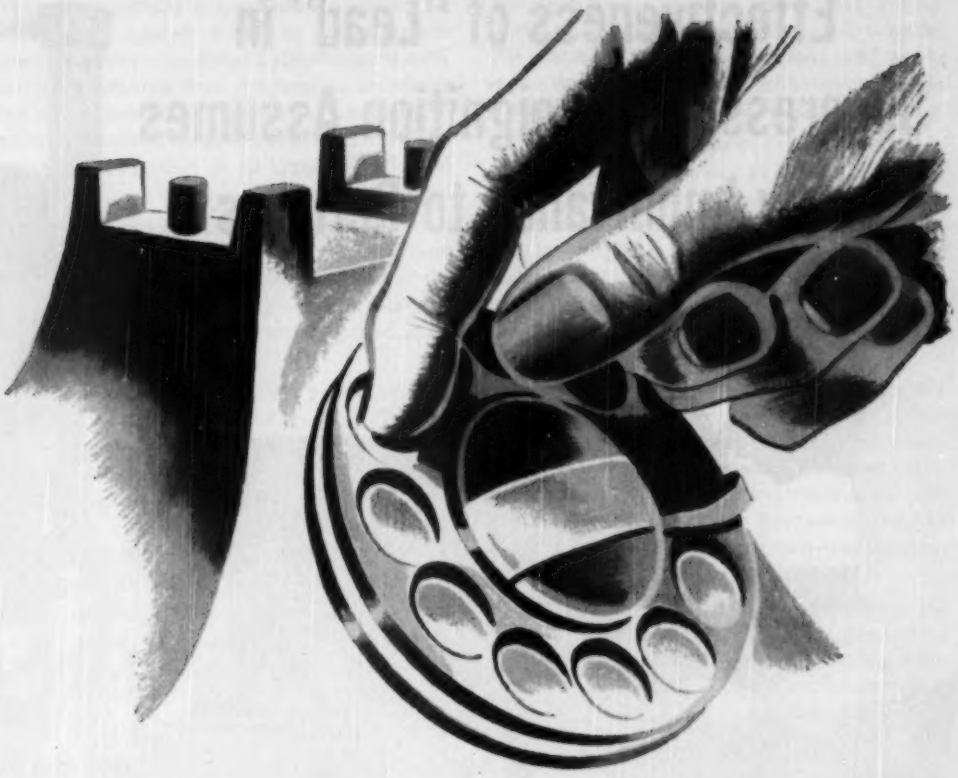


TYPE 6500 TYPE 1900 TYPE 7000



Dependable Selectivity...

Efficient H_2S removal in the presence of CO_2

Dependable, low-cost removal of H_2S in the presence of large volumes of CO_2 is a primary advantage of the Shell Phosphate Process. All but harmless amounts of H_2S are removed while most of the CO_2 is left untouched.

Important too is the fact that the treating process has no harmful effect upon subsequent processing operations. The treating agent is inorganic . . . non-contaminating to hydrocarbons.

Low operating costs are the rule with the Shell Phosphate Process. Since a minimum of CO_2 is removed, steam regeneration of the treating solution costs less. Also, because the regenerated H_2S is in a relatively high concentration, the cost of conversion to solid sulphur or sulphuric acid is greatly reduced.

The Shell Phosphate Process is available to any operator under license from the Shell Development Company . . . together with experienced engineering service for its design, installation, and operation.

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Effectiveness of "Lead" in Suppressing Autoignition Assumes New Importance to Refiners

INCREASE IN
AUTOIGNITION-LIMITED COMPRESSION RATIO
FROM ADDITION OF 3 CC TEL PER GALLON

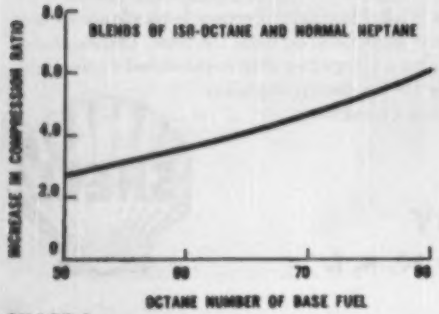

CHART 1.

RELATIVE INCREASE IN
AUTOIGNITION-LIMITED COMPRESSION RATIO
FROM ADDITIONS OF TETRAETHYLLEAD

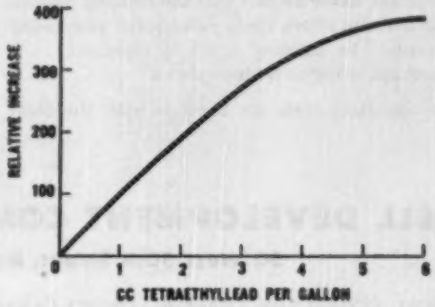

CHART 2

That tetraethyllead is an effective agent for reducing the tendency of fuels to autoignite was demonstrated by the Ethyl Laboratories as early as 1935. Since that time, this original knowledge has been expanded by a continuing research program on the effectiveness of tetraethyllead in suppressing autoignition in all types of fuels and engines.

The most significant fact disclosed by recent research is that the effectiveness of tetraethyllead in controlling autoignition increases both as the antiknock quality of the base gasoline is improved and as the concentration of tetraethyllead is increased.

An engine was driven at 900 revolutions per minute with greatly retarded ignition. The compression ratio was slowly increased until firing was initiated by autoignition of the fuel. The compression ratio was then reduced slightly until firing ceased. This value was considered to be the limiting compression ratio imposed by autoignition.

On this basis, when the base fuel was a 50-50 blend of iso-octane with normal heptane, the addition of 3 cc of tetraethyllead per gallon of fuel enabled the engine to operate without autoignition at 2.6 ratios higher compression. When the base fuel was an 80-20 blend of iso-octane with normal heptane, an increase of 6.1 ratios was permitted as shown in Chart 1.

2nd and 3rd cc of lead highly effective

The high effectiveness of the second and third cc of tetraethyllead in the suppression of autoignition is shown in Chart 2. Two cc are almost twice as effective as one cc; three cc are 2.7 times as effective as one. Additions of tetraethyllead beyond 3 cc per gallon also have a high effectiveness in contrast to the smaller contributions made in raising octane number.

Studies were also made on the effect of tetraethyllead in suppressing the after-running which sometimes occurs when the ignition is turned off. An engine having variable compression ratio was operated with normal ignition at 900 revolutions per minute and full throttle. The compression ratio was increased until, as the engine decelerated to rest after the opening of the ignition switch, it was on the verge of after-firing.

On this engine, the effect of the concentration of tetraethyllead in the fuel on the maximum permissible compression ratio without after-running was made at cylinder jacket temperatures of 212°F and 300°F (Chart 3). The effectiveness of the higher concentration of tetraethyllead, up to 5 cc per gallon is clearly shown.

Tetraethyllead — a double value

For many years the trend in the design of engines for use in ground vehicles has been toward higher compression ratios. This trend, which has raised the temperatures of compression in engine cylinders to values more nearly approaching the self-ignition temperature of the fuel, seems likely to continue—thus requiring even more consideration of autoignition.

The data show that tetraethyllead offers the refiner—and the eventual user of his gasoline—a double value. It is effective in suppressing autoignition as well as knock. Both of these contributions will have increasing importance to refiners in the future.

EFFECT OF TETRAETHYLLEAD ON MAXIMUM COMPRESSION RATIO WITHOUT AFTER-FIRING

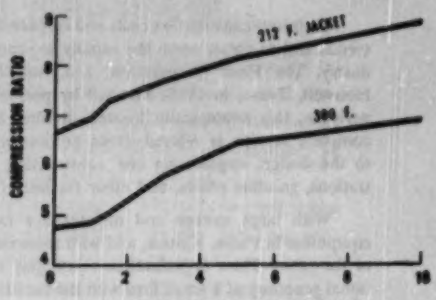

CHART 3

Over 400 specialists working full time on fuel and engine developments

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RESEARCH LABORATORIES

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A complete organization for the design, engineering and construction of facilities for the Mid-Continent gas-gasoline industry!

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With large storage and maintenance facilities for construction tools and equipment in Paola, Kansas, and with recourse to engineering and research talent of the entire Fluor organization, this highly efficient group combines the operational economy of a small firm with the facilities, know-how and financial security of a major company—one with national recognition and over a half century of experience.

Fluor's Houston "Box Score" since 1948

- Gasoline Plant at Beaver City, Texas
- Gasoline Plant at Pickton, Texas
- Compressor Station at Gilbert, West Virginia
- Dehydration Plant at Anahuac, Texas
- Gasoline Plant at Provident City, Texas
- Compressor Plant addition at Golden Meadows, Louisiana
- Compressor Station addition at Tomball, Texas
- Dehydration Plant at Kappersten, West Virginia
- Hydrogen Sulfide Removal Plant at Corpus Christi, Texas
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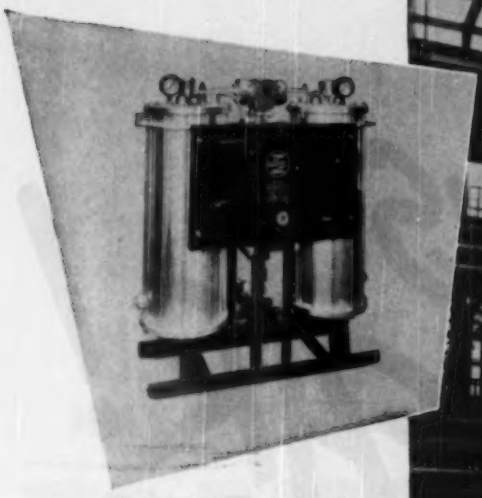
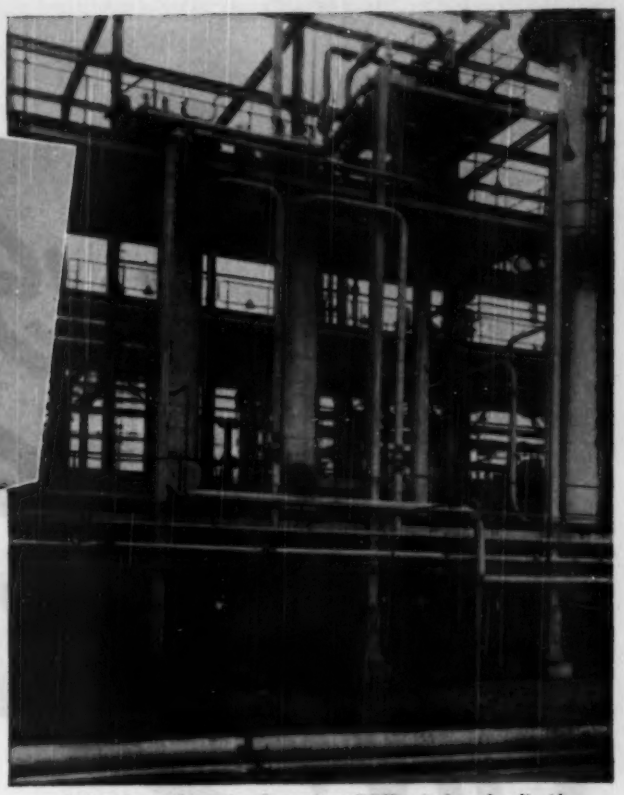


British-built Type BAC Lectrodryer.



This pair of columns is a Lectrodryer DRYing hydrocarbon liquids and gases in a British oil refinery. Built by BIRLEC, Ltd., of Birmingham, England, Stockholm, Sweden, and Sydney, Australia.

WETth
(unwanted moisture)
is an international problem

DRYing with Lectrodryers is worldwide, because WETth plays no favorites. Moisture leads chemical reactions astray, permeates materials being processed and in storage, slowing down production and impairing quality.

Companies that hope to compete in international trade must have the time-and money-saving advantages gained by employing Lectrodryers to remove unwanted moisture.

Air, gases and organic liquids are handled by Lectrodryers—DRYing to dewpoints below −110°F., a few cubic feet per hour or thousands, manually controlled or fully automatic, at atmospheric pressure or 5,000 psi.

Lectrodryer engineers will help you select the equipment you need to do any DRYing job. Write Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
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LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

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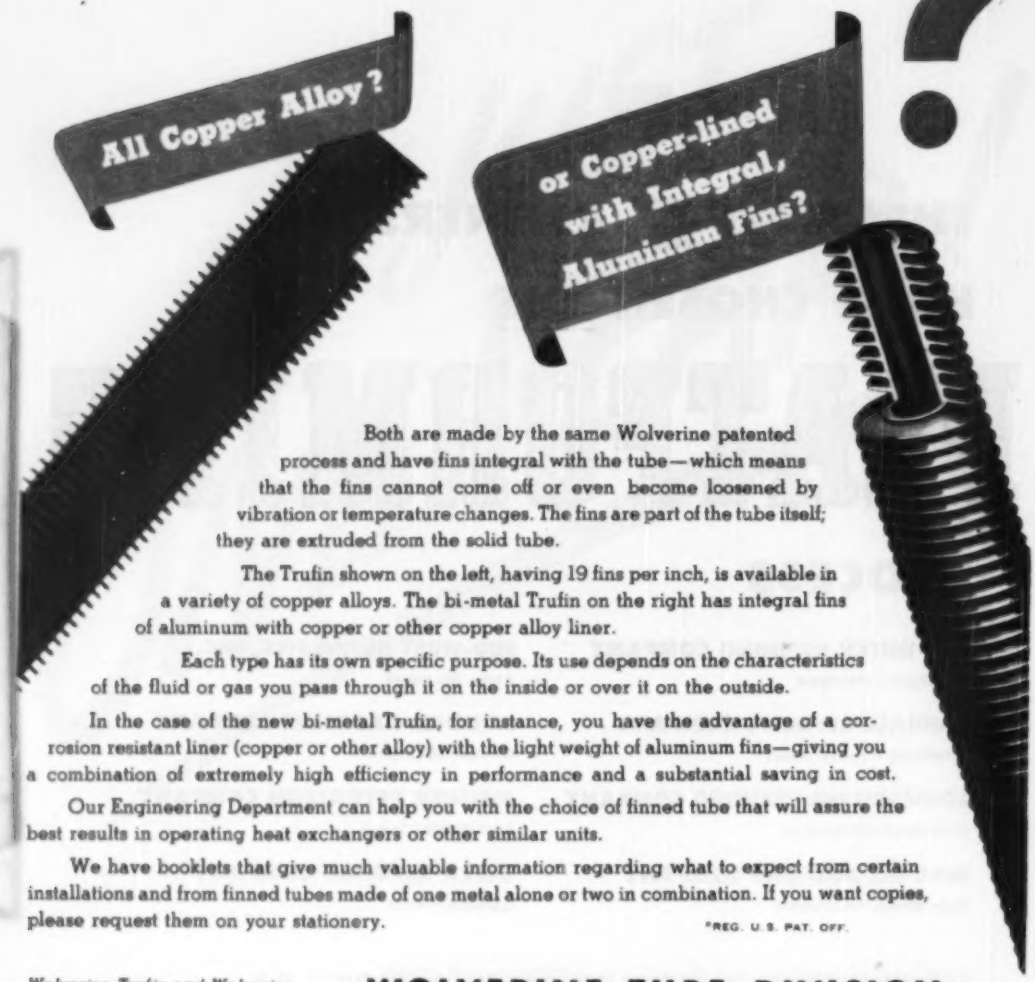
Universal Service Protects Your Refinery

How do you want your WOLVERINE TRUFIN*?



Both are made by the same Wolverine patented process and have fins integral with the tube—which means that the fins cannot come off or even become loosened by vibration or temperature changes. The fins are part of the tube itself; they are extruded from the solid tube.

The Trufin shown on the left, having 19 fins per inch, is available in a variety of copper alloys. The bi-metal Trufin on the right has integral fins of aluminum with copper or other copper alloy liner.

Each type has its own specific purpose. Its use depends on the characteristics of the fluid or gas you pass through it on the inside or over it on the outside.

In the case of the new bi-metal Trufin, for instance, you have the advantage of a corrosion resistant liner (copper or other alloy) with the light weight of aluminum fins—giving you a combination of extremely high efficiency in performance and a substantial saving in cost.

Our Engineering Department can help you with the choice of finned tube that will assure the best results in operating heat exchangers or other similar units.

We have booklets that give much valuable information regarding what to expect from certain installations and from finned tubes made of one metal alone or two in combination. If you want copies, please request them on your stationery.

*REG. U. S. PAT. OFF.

Wolverine Trufin and Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

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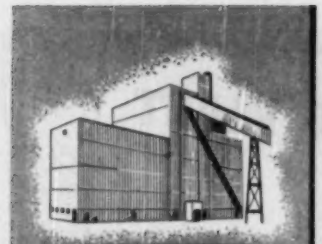
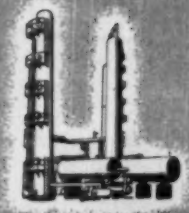
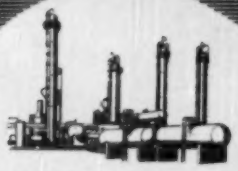


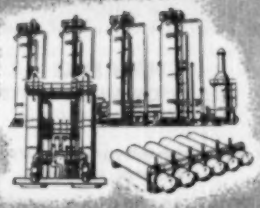
POWER DIVISION



CHEMICAL DIVISION



PETROLEUM DIVISION



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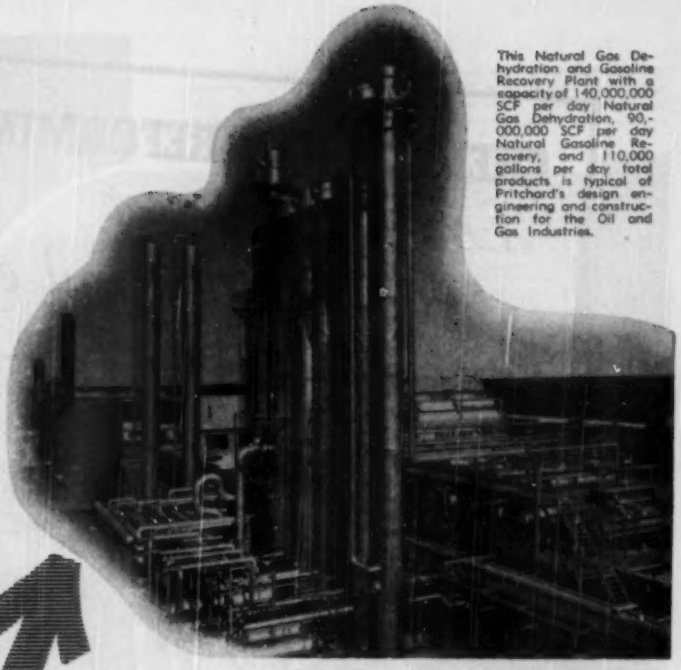

This Natural Gas Dehydration and Gasoline Recovery Plant with a capacity of 140,000,000 SCF per day Natural Gas Dehydration, 90,000,000 SCF per day Natural Gasoline Recovery, and 110,000 gallons per day total products is typical of Pritchard's design engineering and construction for the Oil and Gas Industries.

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Profitable Plants for Industry

In terms of sound design, engineering and construction—in terms of higher profits and freedom from trouble—Pritchard built plants are becoming known throughout the industry for their operational efficiency and quality of production.

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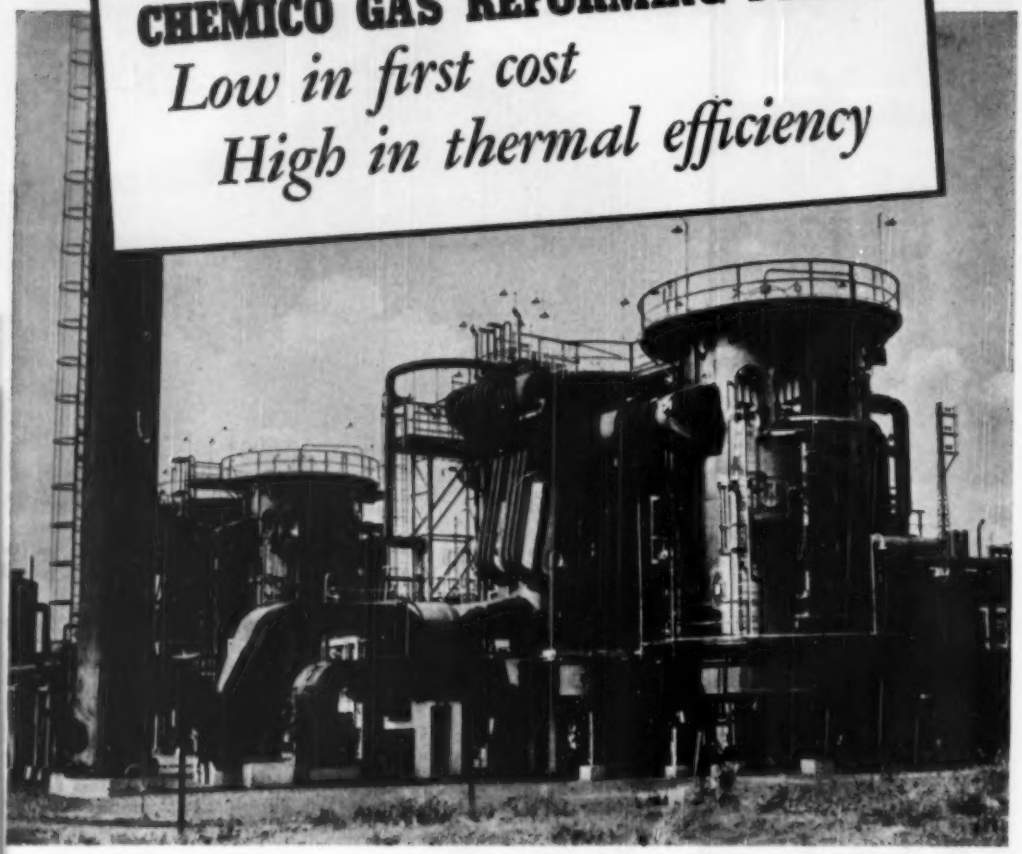
CHEMICO GAS REFORMING PLANT

Low in first cost
High in thermal efficiency



Among the many types of heavy chemical plants Chemico designs and constructs are those for the production of synthesis gas, principally hydrogen. The gas reforming plant, shown above, is located in the synthetic ammonia works of the Office National Industriel de l'Azote at Toulouse, France. It has been operating successfully for a year and a half.

Other Chemico installations for the catalytic reforming of natural gas have been producing for as long as eight years. The total output of all these plants is more than 180,000,000 cu. ft. of reformed gas per day. Four more plants are now under construction in the United States and foreign countries.

Chemico's design provides important advantages. These plants are low in first cost, high in thermal efficiency. Construction is simple. The plant is foolproof . . . requires a minimum of operating and maintenance attention.

CHEMICO
GAS REFORMING PLANTS
are used for making:

- **Hydrogen-nitrogen mixtures for ammonia synthesis.**
- **Hydrogen and carbon monoxide mixtures for methanol synthesis.**
- **Carrier gas for blending with natural gas for distribution by Public Utilities.**
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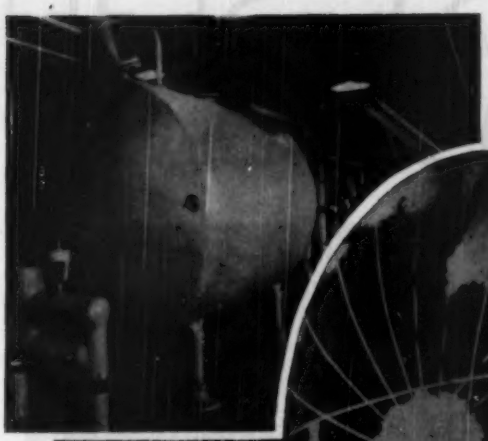
Chemico plants are profitable investments



PC Foamglas insulates this typical equipment used in the manufacture of penicillin, where temperatures range from 0°F. to 200°F. This efficient, long lasting insulation is available in standard flat blocks, curved segments and beveled lags to fit equipment sides, heads and domes, and in preformed sections for standard pipe sizes and fittings.

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● It takes a mighty *effective* insulation to keep refineries and other processing plants running effectively. And it takes a mighty *economical* insulation to keep them running economically. That is why so many engineers are installing PC Foamglas on indoor and outdoor piping, on tanks, towers and other processing equipment.

Its cellular glass structure makes PC Foamglas an effective insulation. Millions of minute sealed glass cells form an excellent barrier to heat travel, thus help to maintain desired temperatures, to minimize condensation.

Then too, being glass, Foamglas has unusually high resistance to moisture, vapor, acid atmospheres, and other elements that cause some materials to lose insulating efficiency. It is noncombustible, odorless and verminproof, has high compressive strength. Consequent freedom from costly repairs, maintenance and replacement makes PC Foamglas a truly economical insulating material.

It will pay you to know all the advantages you get with PC Foamglas. Our specialists will be glad to consult with you regarding your individual insulating problems. Our literature will give you complete information and specifications on the usual applications of Foamglas. Send in the convenient coupon today. Your free copies of this illustrated, informative booklet—and a sample of the material—will be mailed to you promptly.

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The entire strong, rigid block is composed of millions of sealed glass bubbles. They form a continuous structure which has unusually high resistance to moisture, vapor and acid atmospheres, is noncombustible, verminproof and odorless. In these closed glass cells, which contain still air, lies the secret of the material's long life insulating efficiency.

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Please send me without obligation, a sample of Foamglas and your FREE booklet on the use of PC Foamglas for Industrial Insulation.

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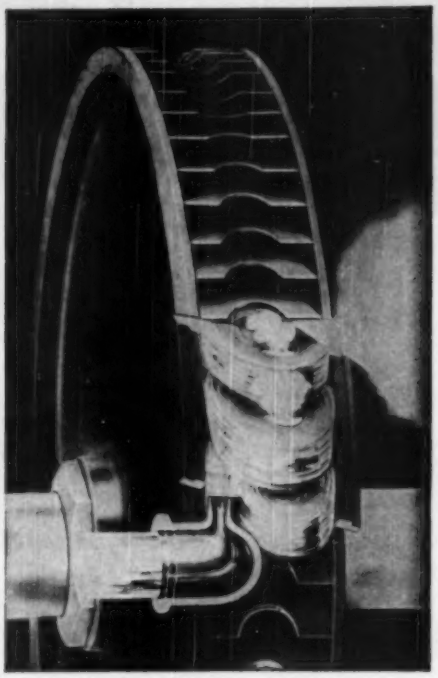
... when you insulate with FOAMGLAS... the insulation lasts!

TERRY



Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

New model K

Centrifugal Sand Pump

ENGINEERED FOR GREATER PUMPING ECONOMY

PATENTED

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Write for Wilfley Bulletin which details the special features, capacities, dimensions and other pertinent information.

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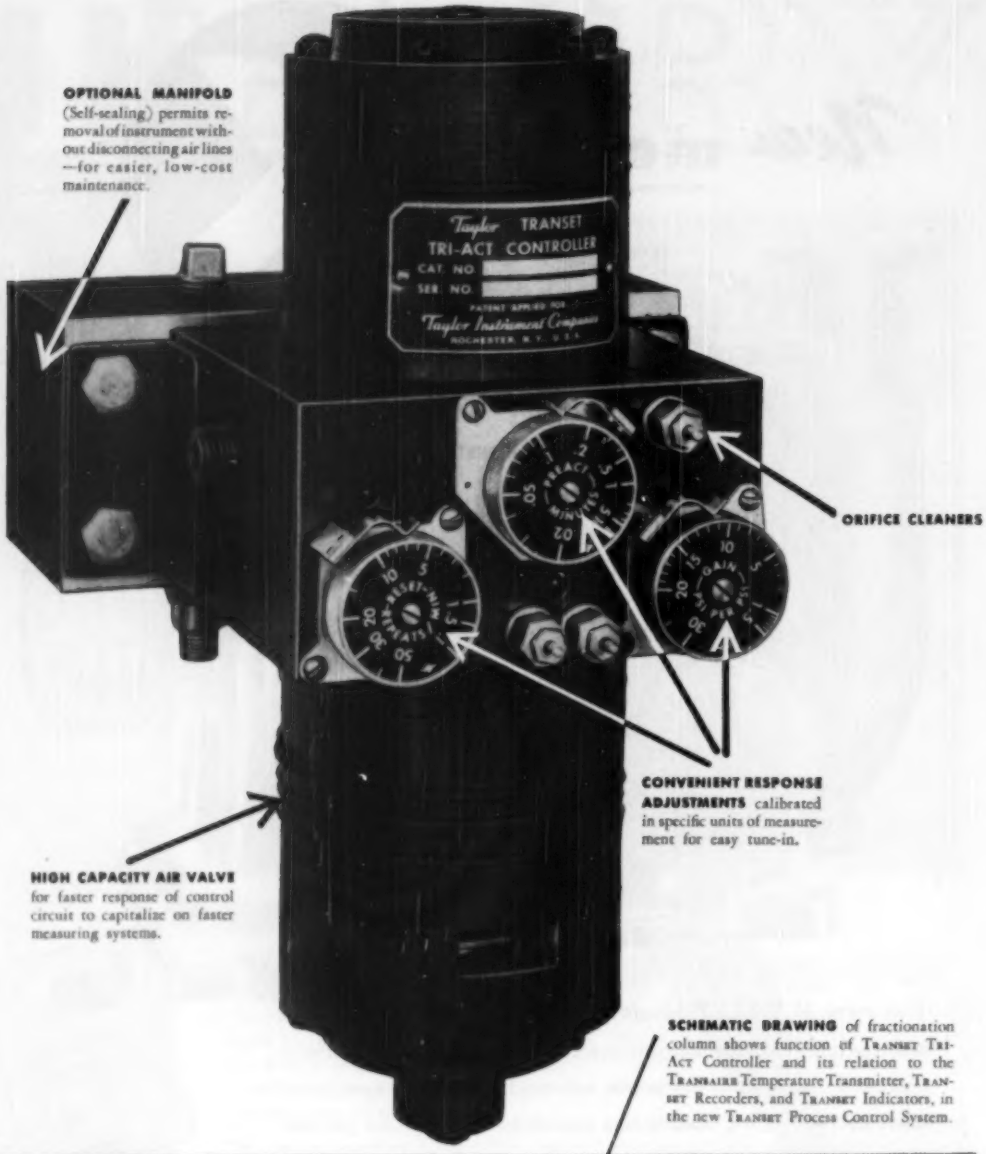

OPTIONAL MANIFOLD (Self-sealing) permits removal of instrument without disconnecting air lines —for easier, low-cost maintenance.

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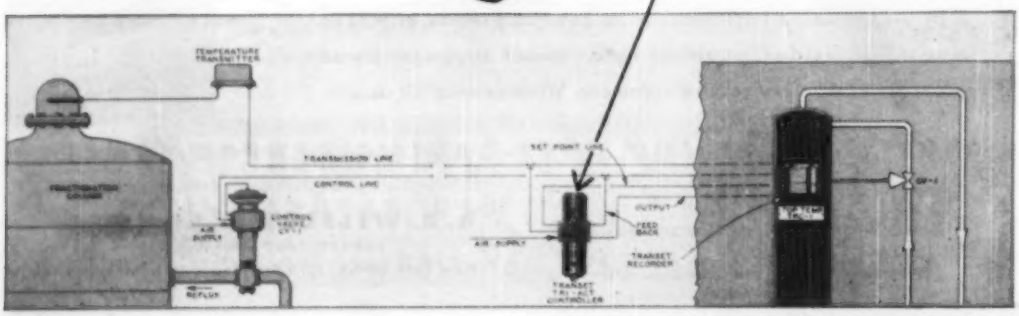
CONVENIENT RESPONSE ADJUSTMENTS calibrated in specific units of measurement for easy tune-in.

HIGH CAPACITY AIR VALVE for faster response of control circuit to capitalize on faster measuring systems.

SCHEMATIC DRAWING of fractionation column shows function of TRANSET TRI-ACT Controller and its relation to the TRANSAIRE Temperature Transmitter, TRANSET Recorders, and TRANSET Indicators, in the new TRANSET Process Control System.



New Taylor Transet*

TRI-ACT*

CONTROLLER!

A Force-Balance Controller with a New Circuit

. . . a New Concept in Process Control

GIVES YOU

1. START-UP WITH *NO* OVERPEAKING
2. BENEFITS OF AUTOMATIC RESET WITHOUT ITS "EVILS"
3. FASTER RECOVERY ON LOAD CHANGES

What It Is—A force-balance controller with a new circuit for pneumatic control systems. The new control circuit combines *two* proportional bands, one with rate action in a closed loop ahead of automatic reset. The first band is shifted by the rate action, and the second band is shifted by the automatic reset. This provides control never before believed possible.

What It Does—The new circuit in the TRANSET TRI-ACT Controller permits 4 times faster reset rate and 4 times faster rate action (PRE-ACT) than conventional instruments! The composite effect of the three responses allows start-up and pneumatic setting with No OVERPEAKING! The faster response settings allow the use of rate and reset responses, *with stability*, on processes where these effects were needed but could not be used.

OTHER HIGHLIGHTS

- Can be locally or panel mounted
- Wider range of response adjustments
- Light weight
- Built-in air strainers

TRANSET TRI-ACT Controller is the latest step in the TAYLOR TRANSET system of control: TRANSAIRE* Transmitters, TRANSET Recorders and Indicators. It creates new standards in accurate pneumatic transmission systems for temperature, pressure, flow or liquid level control.

Write for Bulletin 98097 or, better still, order now from your Taylor Field Engineer! Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

*Trade-Mark

Taylor Instruments

MEAN

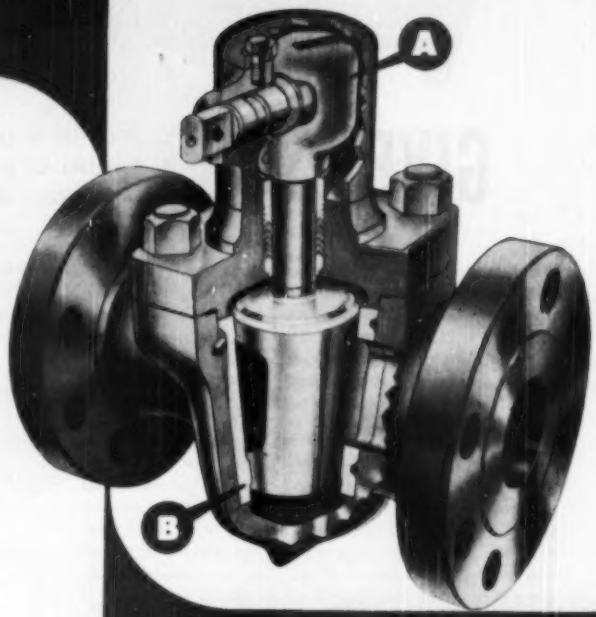
ACCURACY FIRST

IN HOME AND INDUSTRY

HF
ALKYLATE
H_2SO_4

the ACID TEST for any valve, is a cinch for

Cameron
NON-LUBRICATED
LIFT-PLUG VALVES



THE BEST FEATURES OF PLUG AND GATE VALVES COMBINED WITH NEW CAMERON INNOVATIONS

NON-LUBRICATED—no grease of any kind required to effect a seal; prevents contamination of line products; reduces chance for human error and need for maintenance.

PRESSURE SEALING—when plug is seated, line pressure automatically forces seat into tighter engagement with plug—body distortions do not affect the seal.

UNIQUE LIFT-PLUG ACTUATOR—a novel mechanical design which lifts, turns and reseats plug in continuous turn of a lever.

RENEWABLE SEAT AND PLUG—easily replaced; permits any desired trim for specific services.

REPAIRS ON THE JOB—can be completely overhauled without removal from line; no special tools or skill required.

EASY OPERATION—requires less operating effort than other valve designs.

FORGED STEEL—all parts, including body, for most sizes are press or drop forged from specification materials.

Your inquiries are invited, and complete details on the unique mechanical design of the Cameron Non-Lubricated Lift-Plug Valve will be gladly sent on request.

CAMERON IRON WORKS, INC.

P. O. BOX 1212 • HOUSTON, TEXAS

EXPORT: 74 TRINITY PLACE, NEW YORK, N. Y.

PAGE *Welding* ELECTRODES

Page-Allegheny *Stainless Steel*

AC or DC

ARC
—stable even at very low amperage

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—clean, easily removed

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—resists cracking down to very short stubs

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—complete line for welding every type of stainless

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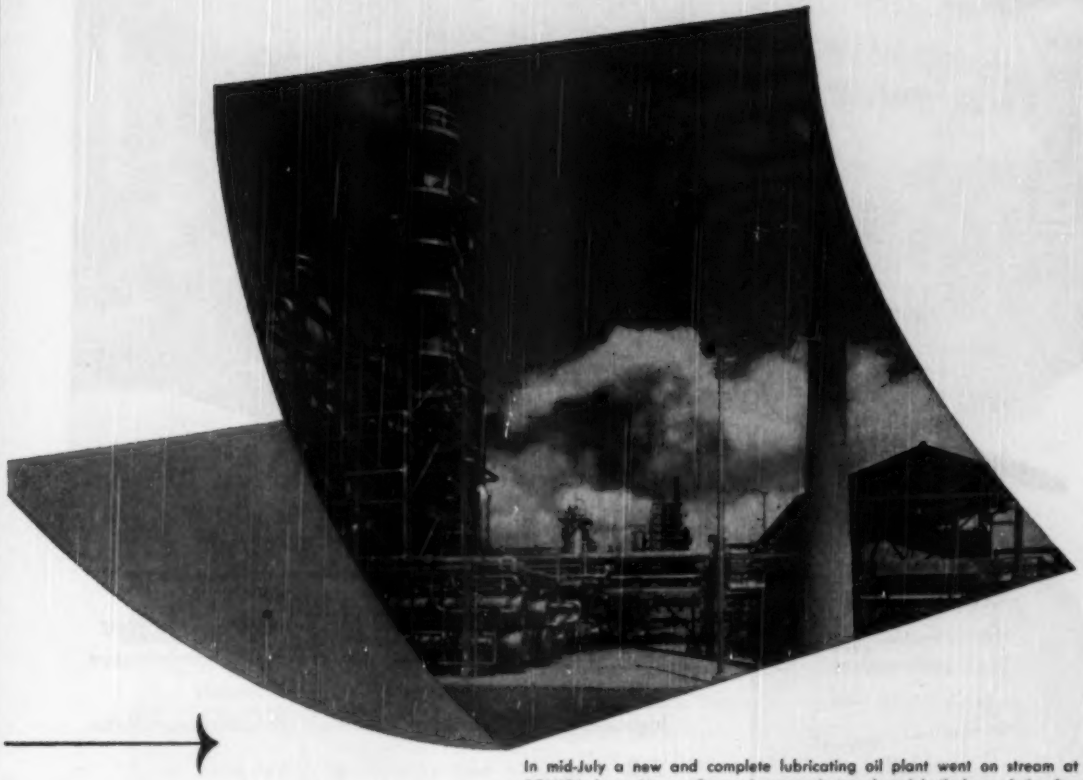
NEW LUBE OIL PLANT FOR SOHIO
designed and built by LUMMUS



In mid-July a new and complete lubricating oil plant went on stream at SOHIO's large Lima refinery. Lummus designed and built four of the five processing units which will produce approximately 1800 barrels per day of high grade lubricating oils.

Lummus applied new and improved techniques in the design of SOHIO's lube-oil plant. A new fluidized method of clay handling is employed in the contact units. A hot oil-belt system provides all the heat required for the FURFURAL, MEK, and CLAY-CONTACT Units. A single console instrument panel is used to control the operation of the FURFURAL and MEK Units.

The Lima plant reflects the leading role Lummus has played in the building of outstanding lube-oil refineries. Lummus has designed and constructed over 115 lubricating oil processing units. To a study of your individual problems, whether solvent refining, the modernization and expansion of existing units, or new projects, Lummus can add the experience gained through years of designing and building petroleum, petroleum chemical and chemical plants.

PETROLEUM HORIZONS, the new 80-page book on Lummus processes and plants, features a step-by-step description and flow sheets for 31 refinery processes. Your copy available on request.

THE LUMMUS COMPANY

designing engineers and constructors for the petroleum and chemical industries

385 Madison Avenue · New York 17, N. Y.

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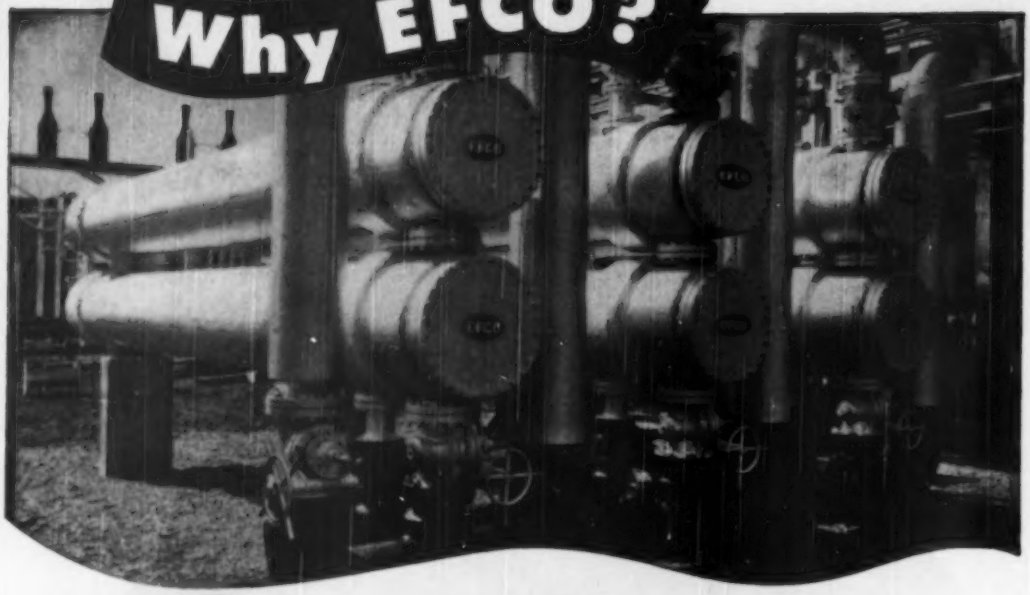
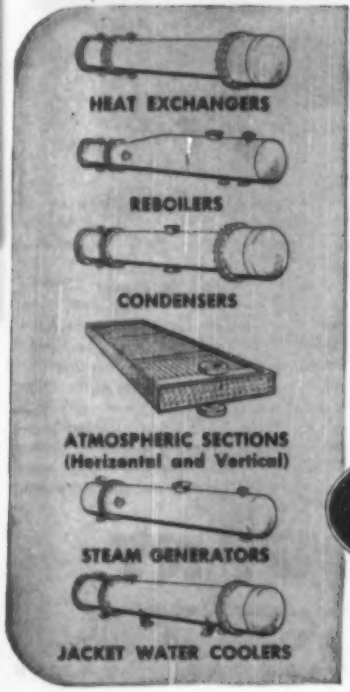
Why EFCO?



Performance is the answer!



With the installation of EFCO heat transfer units in your plant, you will be sure of getting *guaranteed performance* with the extra advantages of low maintenance cost, high operating efficiency, long life and freedom from leaks.

Talk over your heat transfer problems with an EFCO engineer. He will tell you about EFCO installations that have successfully solved problems similar to yours and explain how EFCO equipment will give you the performance you want.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO HEAT TRANSFER EQUIPMENT

The regenerator of this huge Esso Standard Oil Company cat-cracking unit is lined with A. P. Green SK-7 and KS-4. It has been giving excellent service.

ESSO STANDARD OIL COMPANY

Uses

A. P. GREEN SK-7 KS-4

for Regenerator Lining

Application of SK-7 completed. Steel mesh attached to studs preparatory to shooting KAST-SET KS-4.

Interior of Catalytic Regenerator showing the completed lining with the KAST-SET KS-4 applied over the CASTABLE No. 20 SK-7.

CHECK THESE ADVANTAGES OF SK-7 and KS-4

1. Cuts installation time and labor costs
2. Construction costs held to minimum
3. Rebound loss reduced
4. Adaptable to a variety of installations
5. Results in linings with balanced characteristics of poured castables

A. P. Green REFRACTORY PRODUCTS

Esso Standard Oil Company, Linden, New Jersey, is one of the leaders in the petroleum industry who use A. P. Green SK-7 and KS-4 for lining regenerators in cat-cracking units. The contour of cat-cracker regenerators lends itself to the use of these specially designed and engineered gun-applicable refractory castables.

CASTABLE No. 20 SK-7 is a lightweight insulating castable recommended for a service temperature of 1800° F. KAST-SET KS-4 is a castable refractory with a top service temperature of 2750° F. Both were designed specifically for gun application in the Petro-Chemical industry.

For detailed information concerning these castable refractories, write the Engineering Department of the A. P. Green Fire Brick Company — or call your local A. P. Green Distributor.

OUR 40TH YEAR SERVING THE WORLD'S INDUSTRIES

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

In Canada
A. P. GREEN FIRE BRICK COMPANY, LTD.
Toronto 15, Ontario

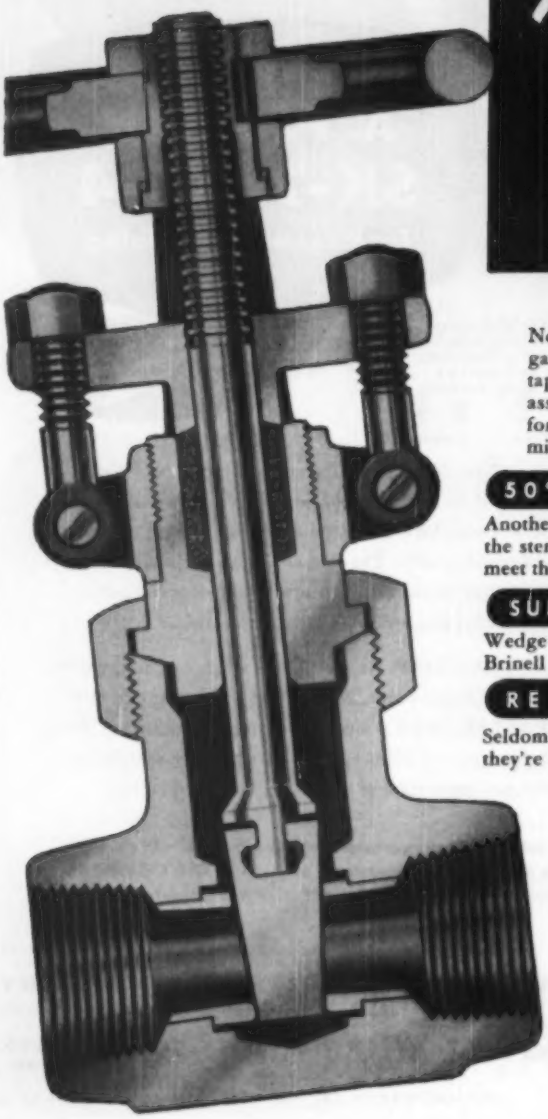
DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD

IF IT'S A

CHAPMAN 960

YOU CAN

Repack Under Full Pressure



No need to interrupt service to repack this small gate valve. You can do it under full pressure, for a tapered shoulder is provided on the stem and gate assembly which engages a seat in the bonnet forging. You repack easily, quickly — with minimum trouble.

50% STRONGER CONNECTION!

Another trouble-saver is the extra-strength now built into the stem and wedge gate connection. It's 50% stronger to meet the most extreme operating conditions.

SUPER-HARDENED WEDGE FACES!

Wedge faces, too, are extra strong — super-hardened to 800 Brinell by the exclusive Malcomizing process.

REPLACEABLE SEAT RINGS!

Seldom is replacement of these seat rings required, for they're hard heat treated — made with wear resisting and non-galling properties. But, if ever necessary, they're made so you can do the job easily...fast.

Specify List 960 in sizes ¼" to 2". Rising stem with yoke (illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. For higher pressures specify List 990.

The Chapman Valve Manufacturing Company

INDIAN ORCHARD, MASSACHUSETTS

Ladish Elbows

...A Complete Size Range Another Reason to Specify *Controlled Quality*

SEAMLESS WELDING FITTINGS

From the small fitting that weighs several ounces to the half-ton giant . . . whatever your fittings requirement, the Ladish line provides you with an unrestricted choice of sizes in a complete range of types, weights and materials. In addition, every fitting offers the added dependability assured by the high manufacturing and metallurgical standards of Ladish Controlled Quality.

THE COMPLETE FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

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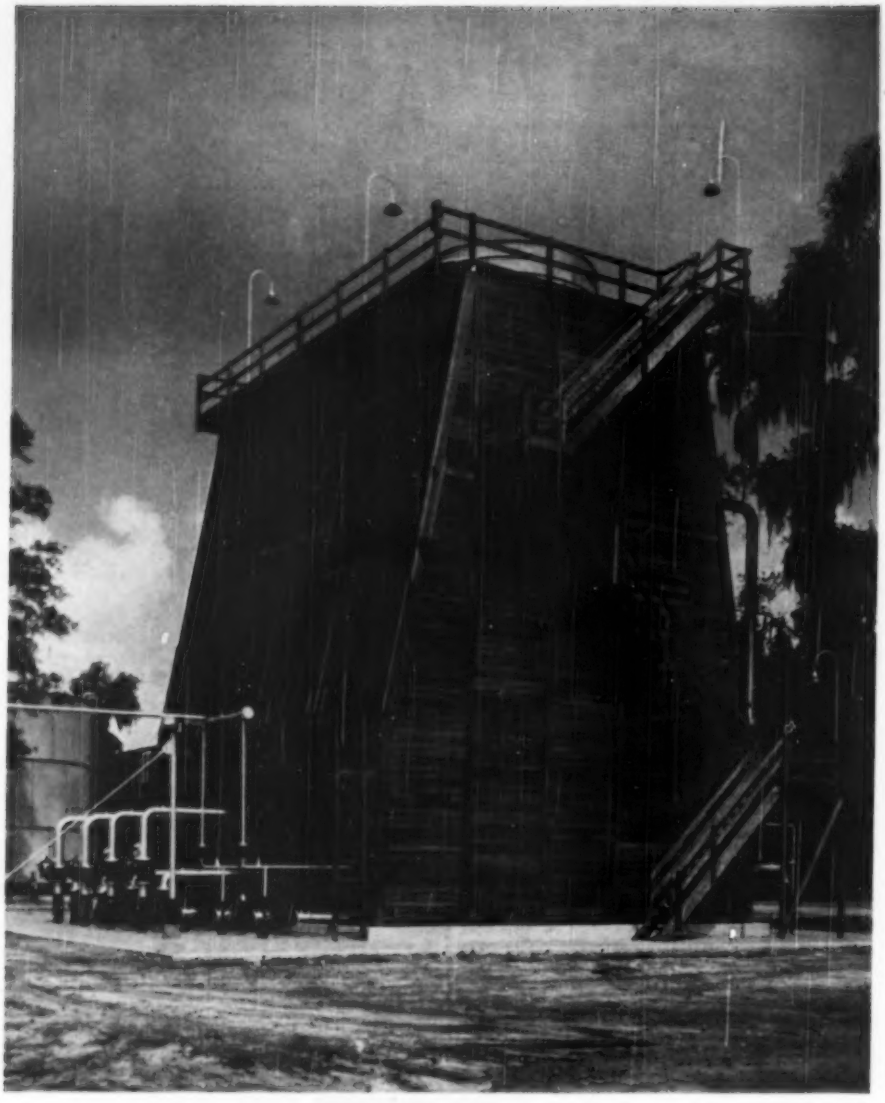
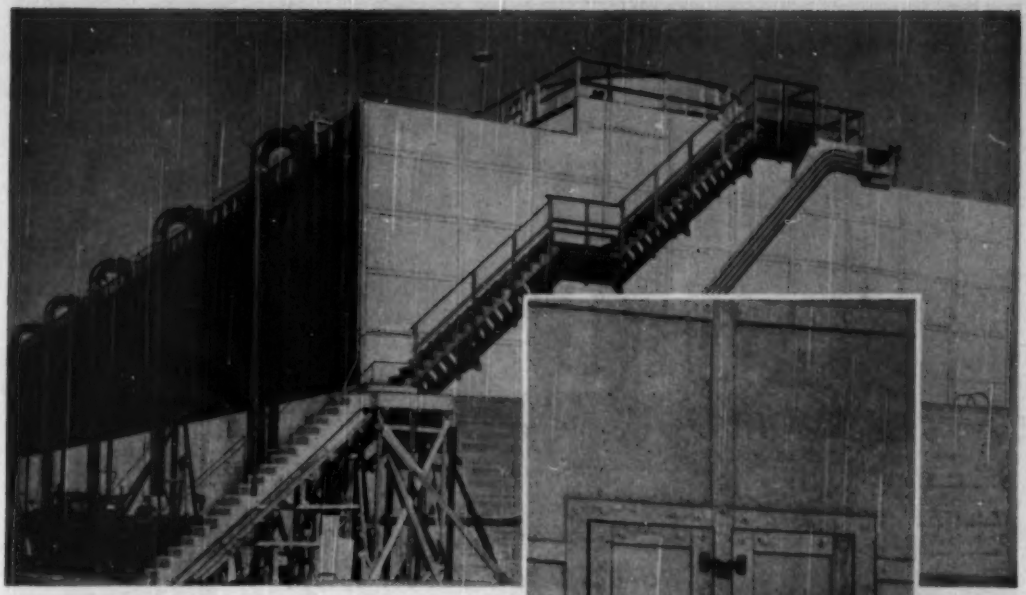


Top Performance

Beauty and utility have been combined in the new TP design. These Top Performance Towers, embodying new but proven advancements in water cooling design, result in lower installation and operating costs, and assure guaranteed performance.

HUDSON ENGINEERING CORPORATION

FAIRVIEW STATION HOUSTON, TEXAS



TWO-FISTED K&M "Century" APAC LICKS DOUBLE THREAT

"Century" ¼" thick APAC ASBESTOS-CEMENT SHEETS were used on this cooling tower at the Mustang Plant of the Oklahoma Gas and Electric Co. Constructed by Marley Co., Inc., Kansas City, Kansas.

Cooling tower temperatures on one side, plus Oklahoma weather on the other, don't bother the K&M APAC Asbestos-Cement Sheets on this job. Always, on any flat surfaces—large or small—outside or inside—K&M APAC is good for years of strictest economy.

APAC sections are large and strong, so that application is simple and quick. Thus erection time and labor costs are sharply reduced. Then comes lasting resistance to every changing season; to fire, rust, rot, rodents and termites. You couldn't have stronger assurance of minimum maintenance. You won't even need painting to preserve the neat, tough APAC surfaces.

For name of your nearest distributor, and all particulars, write to us.

K&M APAC suits your needs...

Use it for any flat panels, partitions, sheathing, shaft casings, bins.

Cut it easily to any needed sizes, right on the job.

Apply it over steel or wood girts, wood studs, solid wood sheathing, insulation board.

APAC Standard Sheet Size: 4' x 8'. Standard Thicknesses: 3/16", ¼", 5/16".

Nature made Asbestos...

Keasbey & Mattison has made it serve mankind since 1873.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

R·P&C

...here's One Reason Why:

Over 60 years ago, a PRATT & CADY Board of Directors passed this resolution:

Resolved:

"That the superintendent
"shall be held responsible
"for the production of goods
"as near perfect in design,
"material and workmanship
"as shall make them merchantable
"and of a character that will serve
"to establish for this company
"a high reputation."

•This policy has remained unshaken through two world wars. The "high reputation" has been maintained. More than ever before, the valves offered by R·P&C meet the demand for longer and better service.

• Houston

Conn.

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

READING-PRATT & CADY VALVES

THERE'S A PETRO-CHEM ISO-FLOW FURNACE FOR EVERY CAPACITY, SERVICE AND DUTY
* LUBE OIL PLANT HEATERS
FOR Crude Distillation • Vacuum Distillation • Solution Reruning
Raffinate Extraction • Asphalt and Deasphalting
Filtrol Distillation • Contact Clay Treating
* GAS AND GASOLINE PLANT HEATERS
FOR Gas Dehydration and Reactivation • Reboiling
Heat Medium Circulating • Rich Oil • Diethylene Glycol
* CATALYTIC PLANT HEATERS
FOR Light and Heavy Gas Oil Heating
Atmospheric and Vacuum Feed Preparation • Reforming
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FOR Gas Cracking • Gas Synthesis
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* FROM 1 TO 70 MILLION BTU'S WITH EFFICIENCIES UP TO 85%
YOU NAME YOUR PROCESS CONDITIONS and we'll tell you where there is a Petro-Chem Iso-Flow* Furnace operating to meet your requirements . . . of the many hundreds now in successful operation, most Petro-Chem Iso-Flow* Furnaces operate beyond their design ratings.
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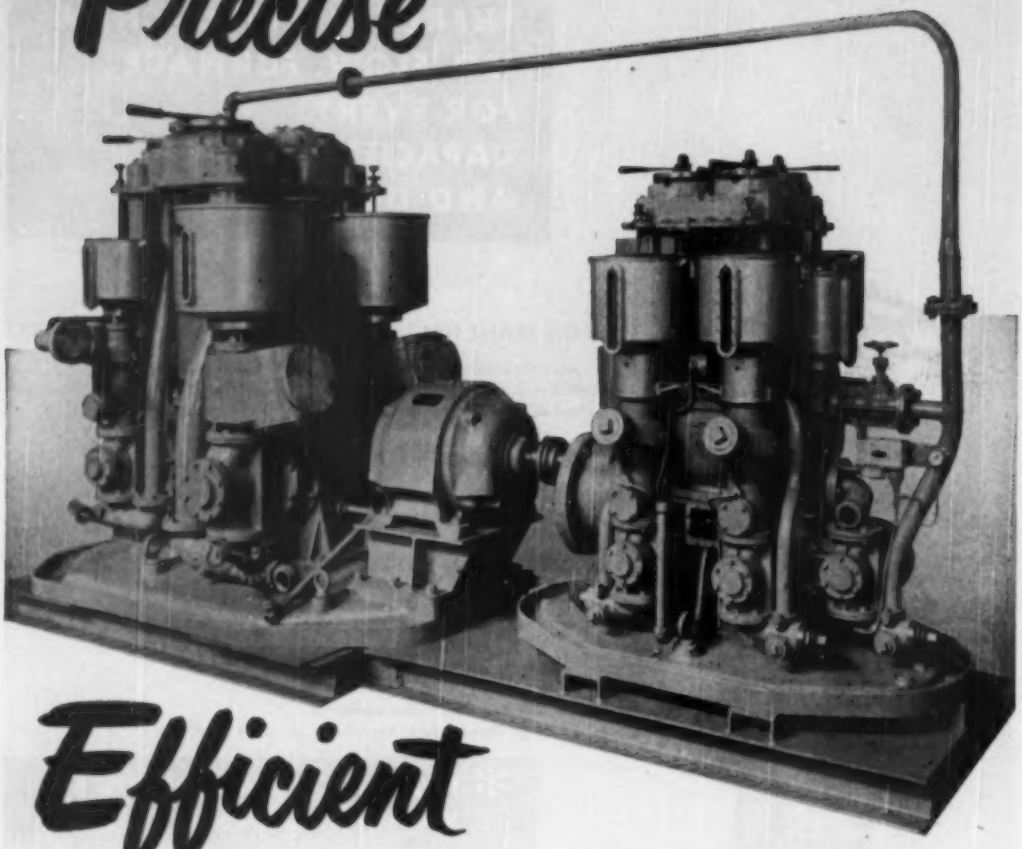
PETRO-CHEM DEVELOPMENT CO. INCORPORATED

Precise



Efficient

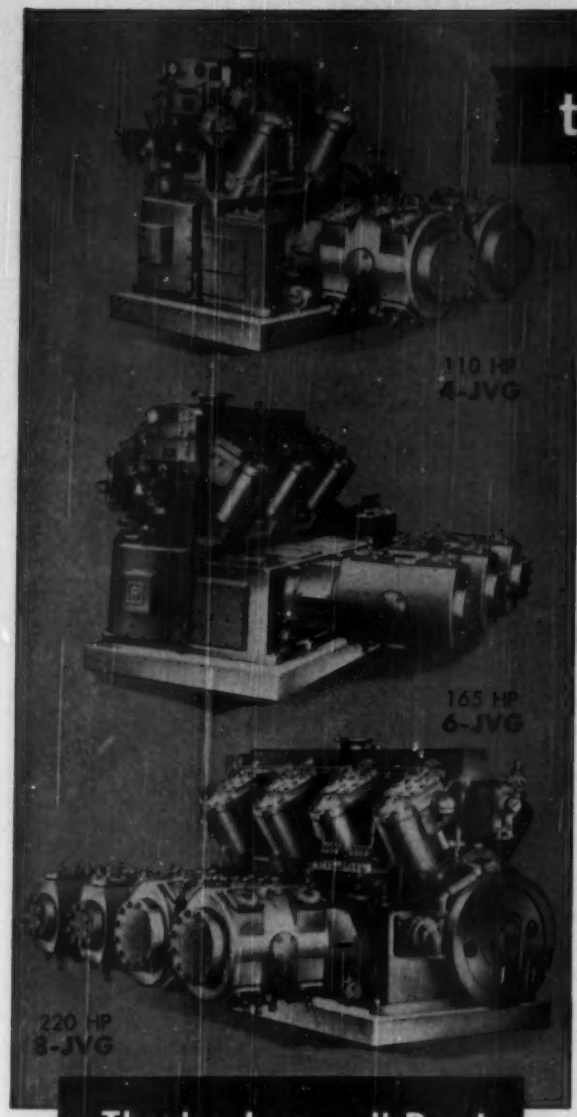
The oil blending machines shown here are examples of the precise and efficient craftsmanship available at Sun Ship. The versatility of our organization and the diversity of our facilities enable us to build with equal success other refinery equipment, chemical plant and industrial machinery; tankers, cargo and passenger vessels. Here, too, are facilities for dry docking and for making all kinds of marine repairs.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE (SINCE 1916) CHESTER, PA.

25 BROADWAY • NEW YORK CITY



try these for size

...and economy!
...and performance!

The light-weight, gas-engine-driven JVG is now available in three sizes ... 110, 165, and 220 horsepower ... for refinery or oil field service. Excellent running balance of these Ingersoll-Rand 4-cycle V-angle compressors, needing only small foundations, makes them ideal for skid mounting and jobs where frequent relocation is necessary.

The JVG is designed for maximum flexibility of loading, to meet any pressure conditions ... any gas ... any service. Maintenance men and operators praise its heavy-duty construction, economy of fuel and lube oil, and simplicity and compactness. They also like the perfect combustion and smooth, quiet 4-cycle operation under all load and speed conditions.

These units will meet your most exacting specifications for high efficiency, conservative rating, long life and low maintenance ... whether the job be for semi-portable use or permanent installation. Consult your nearest I-R representative for complete details.

Horsepower	Width	Length	Height
110	6'-2"	8'-5"	6'-3"
165	8'-3"	8'-5"	6'-3"
220	10'-4"	8'-5"	6'-3"

They're Ingersoll-Rand
JVG
GAS-ENGINE-DRIVEN
COMPRESSORS

4 CYCLE V

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y.

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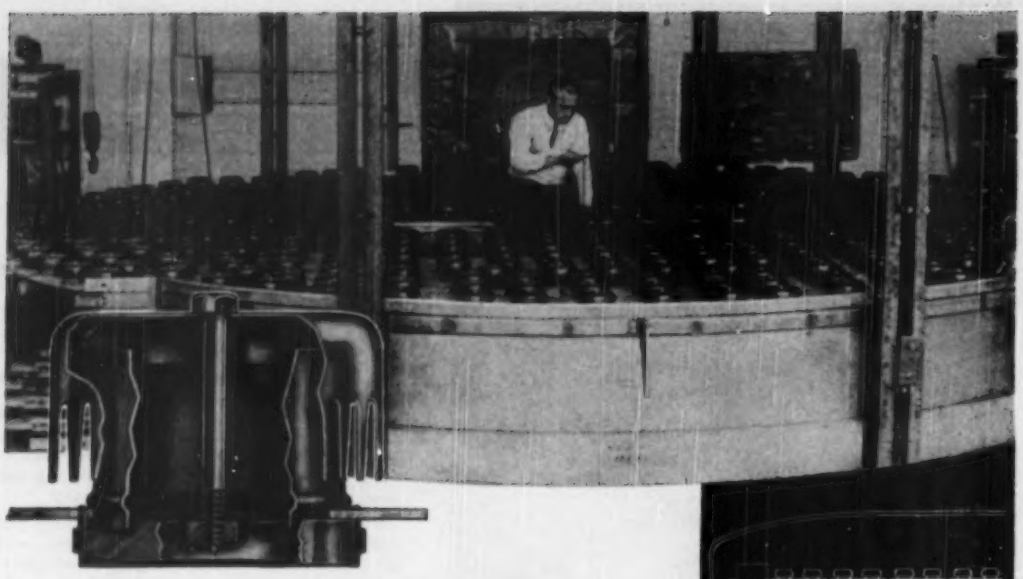
COMPRESSORS • AIR TOOLS • CONDENSERS • ROCK DRILLS • TURBO BLOWERS • CENTRIFUGAL PUMPS • OIL & GAS ENGINES

Types XVG, SVG and KVG gas-engine-driven compressors are available for installations requiring larger horsepower ratings.



proven improvements in bubble tray design—

One truss for every two trays . . . with every alternate tray level free of major supports — this is the new bridge-type truss design that makes Gilbarco Duo-Level bubble trays faster to install, far easier to clean, and more rigid with lighter weight.

New cap assemblies are designed for quick, easy removal by one man working from the top side. There are no flanges or projecting edges around holes to slow up cleaning operations.

A new clamp design with improved packing protection minimizes joint leakage without causing distortion of the trays under temperature changes.

Duo-Level bubble trays, fabricated of alloy metals, are adaptable to refinery requirements either as new equipment or replacements. Gilbarco's large staff of engineers is at your service to demonstrate how Gilbarco bubble trays can be fabricated to meet the requirements of your process design.

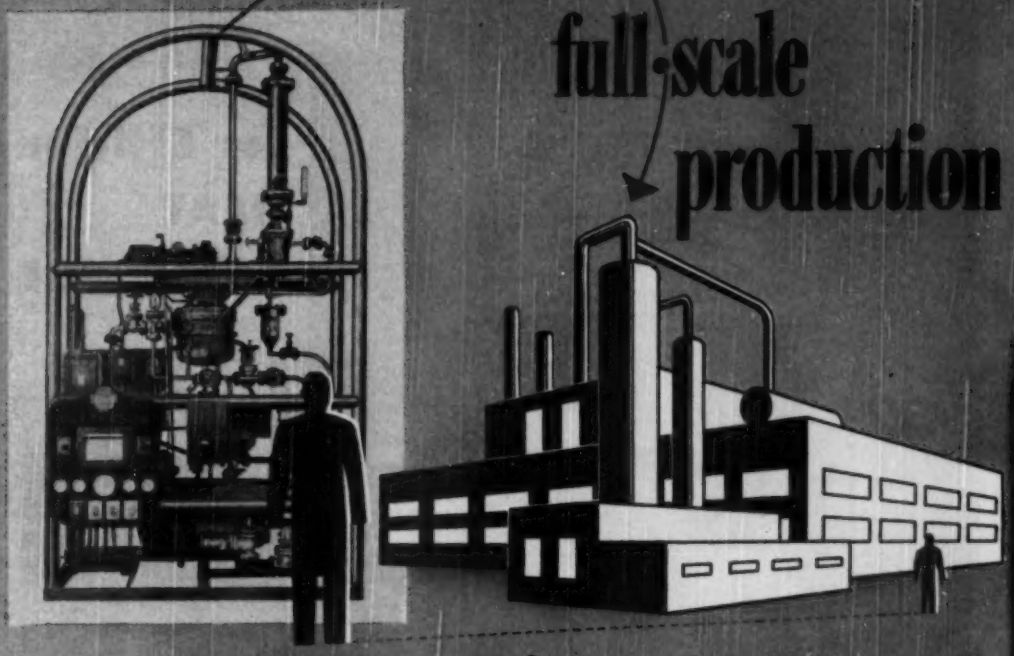
Gilbarco

GILBERT & BARKER MFG. CO.

West Springfield, Mass. Toronto, Canada

Established in 1865

from Pilot Plant to full-scale production



let Patterson engineer the job!

As process engineers we design and build a pilot plant, as well as full production facilities, for grease and other special petroleum products. We furnish the complete unit. We provide you with every essential service for both pilot plant and full scale operation. You profit from Patterson's 80-year record of experience and undivided responsibility. . . . Consult us for full information.

Richard L. Conaway

The Patterson Foundry and Machine Co.

East Liverpool, Ohio, U. S. A.

NEW YORK, BOSTON, PHILADELPHIA, PITTSBURGH, DETROIT, CHICAGO, CINCINNATI, LOS ANGELES, SAN FRANCISCO, SEATTLE

The Patterson Foundry and Machine Co., (Canada) Ltd.

Toronto, Canada

MONTREAL

ENGINEERS • DESIGNERS • MANUFACTURERS for the Process Industries

for Efficient HEAT EXCHANGE

Pictured above is the new Type "E" QUINTAIR *Air Cooled Heat Exchanger*, designed, engineered and manufactured by J. F. Pritchard & Co.'s Equipment Division. Curved Aerofin sections *(see illustration at right)* enable this unit to take maximum advantage of winds from any direction. Especially suited for engine and compressor jacket water cooling.

... Always Specify AEROFIN

Regardless of the heat-exchange application — or the operating conditions which prevail . . . regardless of the type of atmosphere or liquid, Aerofin will supply the design and materials best suited to the job.

Aerofin's unequalled experience, research and manufacturing facilities in the heat-exchange field are your assurance of greatest efficiency and longest service life.

AEROFIN CORPORATION

410 South Geddes St., SYRACUSE, N. Y.

NEW YORK • CHICAGO • CLEVELAND • DETROIT • PHILADELPHIA • DALLAS • SAN FRANCISCO • TORONTO • MONTREAL

Aerofin is sold only by manufacturers of nationally advertised fan system apparatus. List on request.

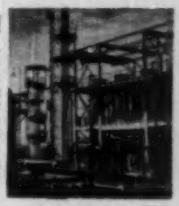
A strange breed of "cat" ... cat-equipment, that is!

ONE of the unusual types of equipment Kellogg is frequently called upon to fabricate is the cat-poly reactor. A strange breed of heat exchanger, it is in reality a combination pressure vessel and heat exchanger, inasmuch as operating pressures in the catalyst-packed tubes reach 1200 psi. Another unusual aspect of these exchanger-vessels is that they are designed to be taken out of service regularly for replacement of catalyst, rather than being built to operate without maintenance for as long a period as possible.

Fabrication of this type of equipment is unusual, too, in the heat exchange field. First, it's on the "grand" scale, tubes being 5 inches in diameter and 40 feet long, and the shells 50 inches in diameter. But probably the most important single fabrication step is *the welding of the tubes to the tube sheets*, replacing the customary roll-in operation. Here Kellogg's unusually broad experience in welding techniques asserts its importance... guarantees the customer finished cat-poly reactors in the minimum time with the maximum service life built in.

One recent order!

An even dozen Kellogg cat-poly reactors are installed in this brand new East Coast refinery. Another three-quarter dozen are now being finished in Kellogg shops, destined for a Midwest plant operated by the same refiner.



Continuing Basic Study of the principles of heat exchange conducted by Kellogg development groups for more than twenty years has produced unduplicated design data.

Shop Layout Craftsmen are fully experienced on all types of heat exchanger fabrication from gigantic marine condensers to intricate jet motor combustion-chamber shells.

To matter temperature, pressure and chemicals use

M. W. KELLOGG

process equipment

Extensive Shop Facilities, including every necessary fabricating step from plate rolling to stud threading, permit *complete* fabrication under same roof of any type of heat exchanger for any kind of service.

Special Shop Techniques permit the economical fabrication of the component parts for each heat exchanger as an individual production order and provide every exchanger with the advantages of "tailor-made" fit and serviceability.

Rigid Quality Control maintained by inspectors reporting directly to *Shop Management* rather than to *Production* executives, maintains quality of work at a much higher level than could be attained by customary control methods.

Heat Exchangers
Process Piping
Bends and Headers
Giant One-Piece Bends
Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells

★

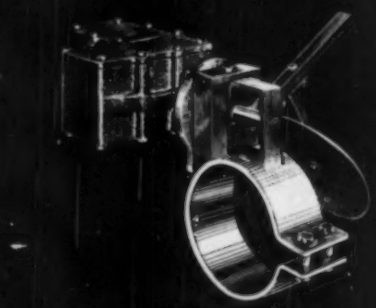
The M. W. Kellogg Company (Subsidiary of Pullman, Incorporated)—Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris

KNOCKOUT BLOWOUTS

with the NEW S&J Mud Flow Measuring System!

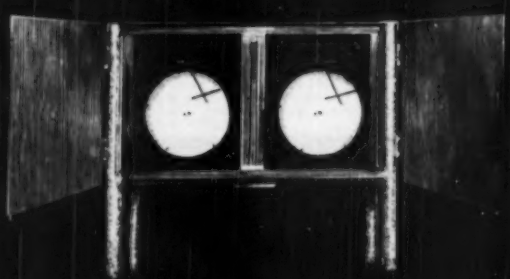
A well blowout always telegraphs its coming via changes in the mud flow cycle . . . sometimes minutes, often hours BEFORE it arrives. To receive and interpret this all-important warning a driller must have a thorough knowledge of mud flow characteristics, and he must have the proper instruments which will supply him with pertinent information, quickly and accurately. Now, Shand & Jurs has just the instruments to answer this purpose. S&J's new mud flow measuring system is composed of the four units shown here. They are interconnected ELECTRICALLY . . . the most accurate and dependable means of transmitting signals from one point to another. Every part of this mud flow measuring system is designed and constructed with the same high quality and careful precision as the other equipment Shand & Jurs supplies to the petroleum industry. Contact the factory, or any of the branches below for further information about this new S&J mud flow measuring system.

The S&J Mud Pit Level Gauge. Located in the mud pit this sturdy, non-tippable, tubular steel-frame supports the transmitting mechanism and heavy duty steel float which is partially counterbalanced.



The S&J Mud Flow Indicator. Mounted over the end of the mud return outflow pipe, the counterbalanced gate measures and transmits changes in the mud flow rate.

The S&J Visual Indicator and Alarm. Mounted on the drilling floor at easy-to-read eye level, it shows at a glance the mud pit level and rate of mud return.

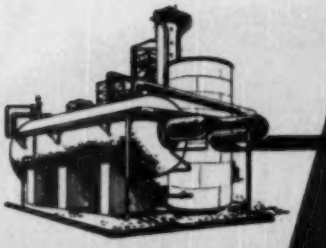


The S&J Mud Flow and Mud Level Recorder. Located away from the rig, free of vibration, this instrument keeps a permanent record of all changes in mud pit level and rate of mud return flow. Driller or relieving crew can refer to these records and note any trend which might indicate the possibility of a well blowout.

Shand and Jurs Co. 917 CARLETON STREET · BERKELEY · CALIFORNIA

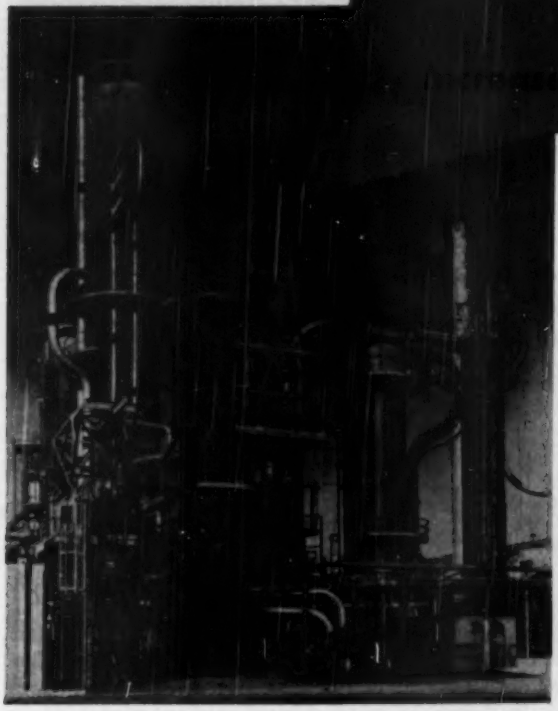
NEW YORK 286 Madison Ave. · CHICAGO 332 So. Michigan Ave. · HOUSTON 910 M. & M. Bldg. · TULSA 310 Thompson Bldg. · LOS ANGELES 714 W. Olympic Blvd. · SEATTLE 3000 Western Ave.

MONTREAL 360 Notre Dame St. · VANCOUVER 550 Beatty St. · DARLINGTON England



TRET·O·LITE

Chemical Desalting



...efficiency by

1. *Preventing frequent shutdowns resulting from coking and corrosion due to salt.*
2. *Removing insoluble solids, which settle in the water phase instead of in other refinery equipment.*

By eliminating the cause of salt troubles, Tretolite Desalting results in better refinery operation with minimum trouble and expense.

When you have a salt problem, ask for a Tretolite desalting survey. The Tretolite Company provides complete desalting service: Consultation, on the spot laboratory testing and plant engineering.

TRETOLITE COMPANY

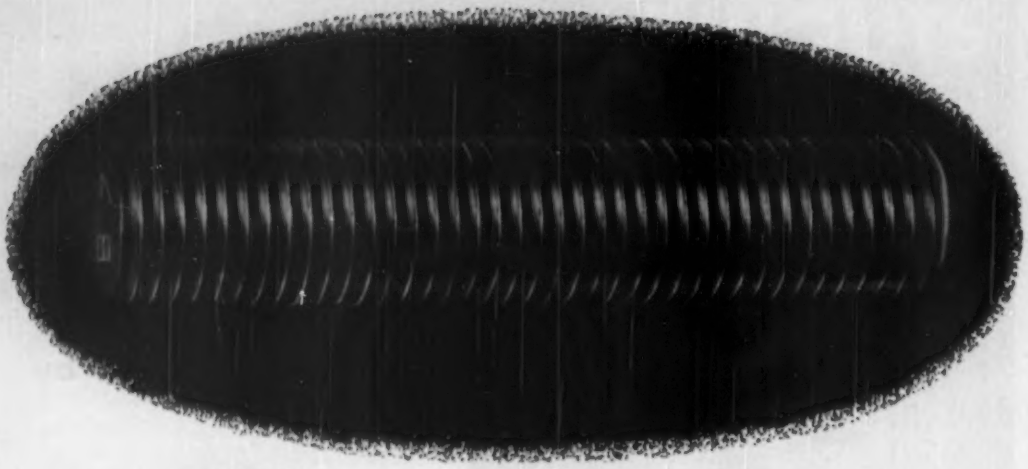
Manufacturing Chemists

ST. LOUIS 19, MISSOURI

CHEMICALS FOR THE PETROLEUM INDUSTRY

DESALTING • DEHYDRATING • WATER DE-OILING • CORROSION INHIBITION • SCALE PREVENTION • PARAFFIN REMOVAL

TD-50-2



Minimizes Stress concentrations

Regardless of the high temperatures and high pressures encountered in refinery bolting jobs, you can be sure of reliable performance when you use the Bethlehem Continuous-Thread Stud.

This is because the Bethlehem Continuous-Thread Stud does such an effective job of minimizing stress concentrations. The stud has no point of thread runout. Consequently, when stresses do occur, they can't concentrate at any one point—instead they are effectively distributed over the entire working length of the stud.

The Bethlehem Continuous-Thread Stud is made from carbon or alloy steels, and comes either plain or heat-treated. It is furnished in a wide range of diameters and in any length, with most sizes carried in stock.

We'll be glad to answer your questions about the use and economy of the Bethlehem Continuous-Thread Stud. Put them up to the nearest Bethlehem sales office, or get in touch with us at Bethlehem, Pa.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Bethlehem supplies every type of Fastener

It's New!... but so much more than just New

TO CONTROL and maintain processes at ideal flow, temperature, or pressure, the new 150# Hancock Bronze Flocontrol Valve is the most efficient and economical valve you can use.

Though it is a fine, strong, leak-defying valve, *it is also a precision control instrument.* The Hancock Flocontrol has a sturdy micrometer dial and pointer securely attached to the valve bonnet. This device enables the operator to "set" the valve at the ideal opening—within a 1/100th turn of the handwheel. And this precise setting can be exactly and instantly duplicated the next day, week, or month.

The scientifically designed V-Port disc *compels proportional flow throughout the entire lift of the valve stem.* Straight-line flow is not dependent upon the short-wearing, fine threads of a needle valve. The Hancock Flocontrol Valve has long-wearing standard Acme threads.

The shut-off seating surface is entirely separate from the controlling V-Ports. Wire drawing and cutting action are minimized; a separate shut-off valve is not needed.

Seats and discs are "500 Brinell" stainless steel. Foreign matter or steam cutting cannot affect their mirror-like finish.

Hancock Flocontrol Valves reduce production costs. They eliminate guesswork in the control of flow, temperature, or pressure.

"PIN POINT CONTROL"
Not just a "catch phrase" but an actuality. The Hancock Flocontrol Valve can be "set" to within a 1/100th turn of the handwheel for precise control of flow, temperature, or pressure.

OTHER HANCOCK FLOCONTROL VALVES FOR HIGHER TEMPERATURES AND PRESSURES

BRONZE FLOCONTROL, 300# W.S.P., 550° F.
Globe & Angle—Screwed Ends—Sizes ½" thru 2"
STEEL FLOCONTROL, 600# W.S.P., 850° F.
Globe & Angle—Screwed & Socket Weld Ends
Outside Screw & Yoke—Sizes ¼" thru 2"
STEEL FLOCONTROL, 600# W.S.P., 900° F.
Globe & Angle—Flanged Ends
Outside Screw & Yoke—Sizes ½" thru 2"

CAST STEEL FLOCONTROL—Screwed Bonnet—
200# W.S.P., 800° F.
Outside Screw & Yoke—
Screwed & Flanged Ends—
Sizes 2½" & 3"
CAST STEEL FLOCONTROL—Bolted Bonnet—
300# and 600# W.S.P., 800° F.
Outside Screw & Yoke—Flanged Ends—
Sizes 2½" thru 4"

Contact your nearest Hancock Distributor for complete information

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

HANCOCK *Valves*

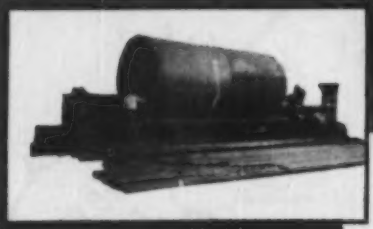
1877 HANCOCK U.S.A.

A PRODUCT OF
MANNING, MAXWELL & MOORE, INC.
WATERTOWN 72, MASSACHUSETTS

Makers of 'Hancock' Valves, 'Ashcroft' Gauges, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties.

FACTS ABOUT STEEL PLATE CONSTRUCTION

that Engineers often need but Fabricators seldom publish



Engineers purchasing steel plate construction often ask themselves the question: "Has this supplier the capacity and the equipment to do the job according to specifications and on time?"

Usually, they are offered little definite information that would help them make a decision. Recently, however, Posey Iron published a 12-page reference bulletin giving details about Posey capacity and equipment.

Located in Lancaster, Pa. . . . a railroad and highway center . . . the modern plants of the Posey Iron Works cover an area of 16½ acres under roof. Manufacturing advantages provided by this extensive, modernized plant often permit the Posey Iron Works to meet both "special" and standard requirements with greater skill . . . greater speed . . . and greater economy. Materials are carefully selected to meet specifications and liberal allowance is always made for safety factors.

To learn of facilities that may lower your steel plate construction costs, write today for your free copy of the Posey Production Facilities Bulletin.

Established 1910

POSEY IRON WORKS, INC.

ELEVATED TANKS
STACKS • TANKS
STORAGE TANKS
GENERAL STEEL
PLATE FABRICATION

STEEL PLATE DIVISION
formerly LANCASTER IRON WORKS, INC.

LANCASTER, PA.

DIVISIONS
BRICK MACHINERY
FOUNDRY • INDUSTRIAL
HEATING • IROQUOIS
SHIPBUILDING
STEEL PLATE

Zallea Expansion Joint News

PUBLISHED BY ZALLEA BROTHERS—WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS EXCLUSIVELY

Expansion Joint of the Month

OPERATION D-E-E-P FREEZE

LOW PRESSURE TYPE

The Zallea Low Pressure Corrugated Expansion Joint is used to absorb vibration and protect machinery. Made of stainless steel, these joints are of the non-equalizing type and are limited in

Figure 7

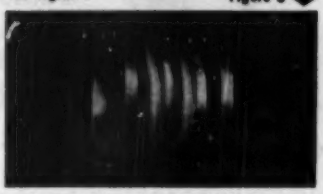


Figure 8

service to ½" maximum axial movement and 50 lbs. maximum working pressure. Furnished with a single corrugation (Figure 7), or with multiple corrugations (Figure 8), they are primarily used on condensers, turbines, stage bleeders, pumps, and between connected equipment where slight movement and vibration occurs. Industry, with its increasingly high temperature problems, relies on the Zallea Low Pressure Corrugated Expansion Joint for smooth flow and maximum operating performance. For your expansion problem, always specify the *best* in expansion joints . . . specify *Zallea*, you'll find it pays!

The supply is going fast . . . send *TODAY* for your copy of Catalog 47, a text book and valuable reference source on all Zallea Expansion Joints.

ZALLEA BROTHERS, 890 Locust Street, Wilmington 99, Delaware

Our Readers Ask

Q. *A friend and I recently had a friendly argument over copper vs stainless steel expansion joints. What are your views? A. T. M., Conshohocken, Pa.*

A. Except where corrosive conditions prevent, stainless steel may be used wherever copper is used. Although slightly more expensive in its initial cost, the use of stainless steel will result in much lower overall cost because of its increased life. Having approximately three times the tensile strength of copper, stainless steel elements can be made with a wall thickness approximately ⅓ that required for copper to withstand the same working pressure. As the life of a corrugated element varies inversely with the thickness of the element, a stainless steel expansion joint will last several times longer than a copper expansion joint designed for the same operating pressure.

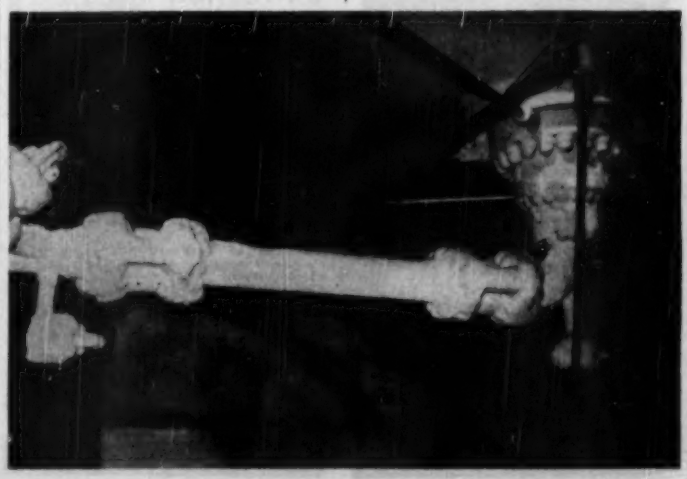
Your questions are welcomed. Address all letters to Engineering Dept. 917.

Temperature and Pressure Problem Solved by Zallea

Recently Zallea engineers were faced with a problem of developing expansion joints for operation on a liquid oxygen line, operating at —320° F., under extreme pressure at a large classified government facility. Because of the unusual nature of this installation, Zallea engineers designed *both* the piping layout and the expansion joints. Special stainless steel alloys were selected for the expansion joints to withstand the severe operating conditions.

Zallea Joints Tested

Shown here in operation, under a heavy layer of frost, are two of a group of 14 six inch Zallea Toroidal Hinged Type Stainless Steel Expansion Joints, with stainless steel construction throughout including the hinges and flanges. Prior to shipment, these Zallea Stainless Steel Expansion Joints were factory-tested to 1400 pounds hydrostatic pressure for a period of 8 hours to insure long life and satisfactory job performance.



ENTRAINMENT SEPARATORS and MIST EXTRACTORS

Give Efficiency and Economy To *Your* Equipment

In any equipment handling liquid and gas phase materials entrainment occurs. York Separators eliminate entrainment! Higher vapor velocities can be used!

The better operating performance of York Separators gives you:

- Improved overhead product quality
- Elimination of product entrainment loss
- Increased production through use of greater vapor velocities

York does not make or sell separator vessels! In all cases our Separator Elements can be readily installed in your present equipment, eliminating the need for an additional vessel and piping.

Because of the high percentage of free volume in York Separators, pressure drop is negligible. Made of any material that can be drawn into wire form, in any shape or size, one-piece or sectional, York Separators are available at a cost low enough to make installation a practical money-saving step wherever entrained liquid is present.

York engineers will gladly share their wealth of "know-how" to solve your entrainment problem and increase the operating efficiency of your equipment.

We are in Chemical Engineering Catalog

York OTTO H. YORK CO., INC.
ENGINEERS AND MANUFACTURERS — 67 GLENWOOD PLACE EAST ORANGE, N. J.

York Separator Uses Extended in Refineries

Recent orders for York Separators reveal a multitude of refinery uses. Originally designed to improve the quality of lube distillates these separators are now widely used in *vacuum towers* to improve the quality of gas-oil charging stock to catalytic cracking units.

Among other uses for which York Separators are being purchased are: effecting complete separation and giving maximum yield of liquid products in *gas scrubbers;* recovering solvent free from asphalt in *extract vacuum towers;* obtaining a clean distillate in *vacuum tower lube rerun stills* giving as a result a substantial saving in subsequent treating operations; eliminating operating difficulties caused by entrainment in *soda regenerator towers;* eliminating mist in *acetylene separators;* effecting clean separation in *naphtha stripping towers;* separating vapor from liquid for efficient operation in *Dowtherm boilers;* insuring liquid-free gas in *air surge drums;* and providing clean, dry steam in *steam drums.*

York Solvent Extractor Now Used in Refining

Developed for chemical processing, the York-Scheibel multi-stage Solvent extractor is now being used in petroleum refining operations such as lube oil solvent refining with the usual solvents; caustic treating and caustic dehydration; acid treating; removal of aromatics; mercaptan and hydrogen sulphide removal from liquid stocks; petro-chemical product separations; and other liquid-liquid contacting operations.

2 Valuable Booklets for Better Process Operations

Solvent Extraction Booklet No. 12

Contains equipment description; applications; plant scale, pilot plant and laboratory information for all users of solvent extraction operations.

ENTRAINMENT SEPARATORS and MIST EXTRACTORS

Advantages of York elements in vacuum pipe still towers, stripping towers, gas absorbers, scrubbers, dehydrators, knockout drums, evaporators, etc.

Bulletin No. 11

YOURS FREE

York OTTO H. YORK CO., INC.
ENGINEERS AND MANUFACTURERS — 67 GLENWOOD PLACE EAST ORANGE, N. J.

SOLVENT EXTRACTION

The HEART of the Most Economical... Most Efficient . . . Extraction Process

YORK-SCHEIBEL Multi-Stage SOLVENT EXTRACTOR

Here is practical, economical and highly efficient equipment for performing all liquid-liquid contacting operations.

For present, or proposed, processes on a commercial scale, York engineers will design and build equipment of any size from 6 inch I.D. to 15 feet I.D. to process 100 gph or 10,000 bpd in 2, 10, 20 or even 50 stages. Pilot plant and laboratory columns from 1" to 6" I.D. are standard equipment.

High throughput capacity and high efficiency without limit to the number of stages, low stage height, low maintenance cost and low initial cost are features which no other equipment for performing similar operations can claim. Separating efficiency, in fact, is so high in a great many cases structural isomers can be separated to pure products.

In addition to structural isomers, this Extractor should be considered for effecting separations where distillation cannot be employed conveniently or economically, as in close-boiling mixtures, azeotropic mixtures, non-volatile mixtures, materials from dilute solutions, impurities and color bodies and heat sensitive materials.

York-Scheibel Extractors (Patented) for laboratory, pilot plant or plant scale operations can be made of practically any material of construction; with any number of stages to give the precision of separation desired.

A 1" I.D. Laboratory Extraction unit with eleven stages is available from stock for use as a general research tool, for analytical work and for process development purposes.

We are in Chemical Engineering Catalog

York OTTO H. YORK CO., INC.
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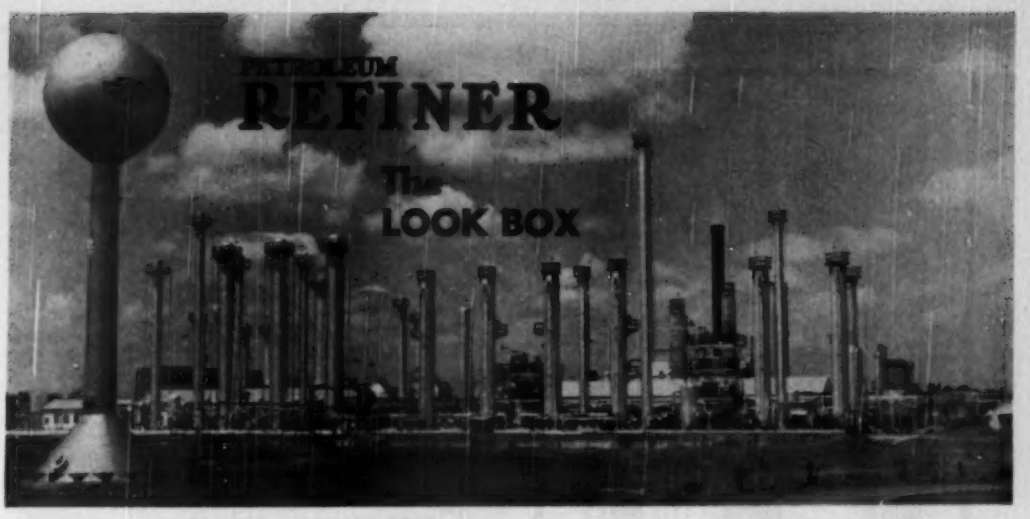


ABOUT the middle of last year, the management of Phillips Petroleum Company decided to close the refinery at Okmulgee, Okla. The plant was losing money.

Refinery Kept On Stream

In the meantime, a small group of the plant's personnel, unaware of their management's decision, had discovered that retail sales of their company's products ranked a poor fifth in the city and surrounding territory. This condition existed despite the fact that Phillips had the only refinery in the city and the third largest payroll. The group decided the matter was of great interest to them and that something should be done about it. The aim of this small group of refinerymen, which later became a committee was to boost Phillips local retail sales. But the spirit of the committee was contagious and the group expanded to include all the refinery's personnel, their families, and all Phillips Okmulgee service station owners.

The story of their efforts, some of the highlights of which are touched on here, is most unusual. The organization promoted retail sales of products to boost the company from fifth to fourth, then third place and finally to first place in the area. They held open-house displays of company products to further community good will. The wives conducted cake and pastry sales and contributed the money to the "campaign" fund.

"The Spirit of 66," was chosen as a slogan to spark the effort whereby purchase of company products by employes and other Okmulgee citizens was promoted. But before some of the organizations successes were more than plans, came word that that plant was almost certain to be closed. For two weeks the committee did not have the courage to meet, but on the third week they decided to go ahead with their work anyway.

Both personnel and management agreed that the plant could be operated with a smaller staff and that some employes would have to be transferred to other Phillips' plants. A plan was evolved, chiefly the work of George Bishop, superintendent, and W. M. Keeler, vice president of refining. It consisted of a list of changes and suggestions to reduce operating costs of the plant to an economic level. But even then, they could not say that the plant would be saved.

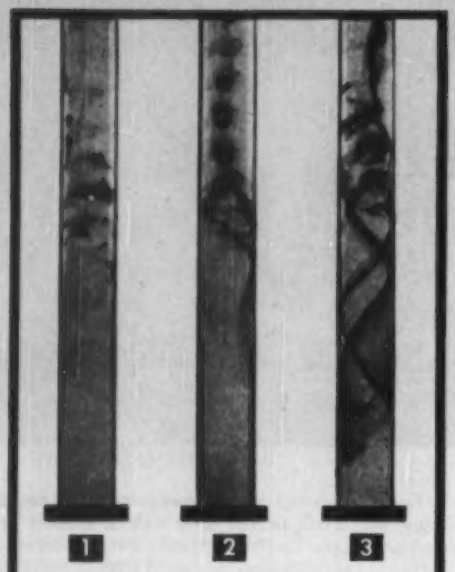
At that time the payroll contained 206 employes—today it has 108. The plant is processing 18 percent more crude oil than before for a total of 8500 barrels per day. The plan finally was accepted by the refinerymen although it meant that many were voting on a chance for some of their neighbors to stay in Okmulgee. Those transferred lost residence in Okmulgee, and because of certain clauses in union contracts, some lost seniority, grade, and salary, in other company plants.

The Okmulgee group won a company-wide stock-purchase contest and at the dinner given them as a prize, K. S. Adams, president of Phillips, handed them another wonderful prize—he told them that the plant would not be shut down.

Reasons for continuing the plant, he said, was reduction in plant operating costs through employe cooperation, increasing efficiency, and the demonstration of personnel loyalty. In addition to continuing the plant, Adams announced that a polymerization unit would be built to increase the plant's capacity—the first new construction at the plant in many years.

Since winning the battle to keep their plant operating as a good business venture, the refinerymen have not discontinued their efforts for further improvements. In April of this year, the plant completed one million man-hours without a single disabling accident. The next month they held one

Top-of-Page Photo—United Gas Pipe Line Company's newly enlarged natural gasoline plant, shown in the picture, is located at Carthage, Texas.



Glass manifolds from single cylinder engines demonstrate the lessened deposit-forming tendency of Oil Blue A. Observe the small amount of deposit found in No. 1 (using Oil Blue A), compared to No. 3 in which the old Oil Blue was used. Yet the original color strength of the two gasolines tested was the same. The relatively small deposit found in No. 1 is the result, not only of the reduced deposit-forming tendency of Oil Blue A, but also of its considerably higher tinctorial strength.

No. 1 operated on gasoline containing .5 gram Oil Blue A/100 gal. gasoline.

No. 2 operated on gasoline containing 1.0 gram Oil Blue A/100 gal. gasoline.

No. 3 operated on gasoline containing .75 gram Oil Blue/100 gal. gasoline.

Du Pont Oil Blue A

Gives Desired Color Intensity with Lower Concentrations

If you use a blue dye in your gasoline, and particularly if you are producing civilian aviation gasoline, you should investigate the economy and lessened deposit forming advantages of Du Pont Oil Blue A. Meeting the requirements of Specification MIL-F-5572, it may also be used in aviation gasolines intended for military use. It is approximately 35% stronger than the previous Du Pont Oil Blue, several times as soluble, and can be used in lower concentration to obtain the desired color intensity.

Easier to use, Du Pont Oil Blue A comes in a non-caking, free-flowing, highly soluble crystalline form, thus simplifying the preparation of stock solutions or the direct dyeing of gasoline.

Ask your Du Pont Petroleum Chemicals representative for samples and complete information, or write the nearest Petroleum Chemicals District Office.

Ask your Du Pont Petroleum Chemicals representative for a copy of this bulletin on Du Pont Oil Blue A. It contains complete specifications, suggested blending schedules, and test results.

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Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

Make Du Pont the Source for All of Your Gasoline Additives . . . Tetraethyl Lead Compounds (Motor Mix – Aviation Mix)—Antioxidants—Metal Deactivator—Dyes

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Okmulgee's Famous Signboard

of their most outstanding promotions—a silver dollar payday—and astonished the city with the importance of the refinery payroll.

A strong indication that the employe organization has no intention of discontinuing its work are the four sign boards it has erected at various points in the city. One of these signs is shown in the photograph. These signs welcome visitors to the city and tell them it is the home of a Phillips refinery and Phillips employes. The sign bears the emblem of "The Spirit of 66." Both materials and work were donated by the employes. Each sign contains a silhouette of the refinery reasonably accurate, except for one addition that cause employes to smile when they are questioned about it. That addition to the silhouette is a catalytic cracking unit—obviously a broad hint directed at management.

Comment and Commendation

A LETTER from A. R. C. Markl, Chief Research Engineer, Tube Turns, Inc., Louisville, Ky., comments on the article titled "Equipment Stresses Imposed by Piping" which was written by F. E. Wolosewick and published in the August, 1950 issue of PETROLEUM REFINER. To quote Mr. Markl:

". . . F. E. Wolosewick refers to certain data given in a paper I presented to the ASME in 1939 in collaboration with D. B. Rossheim of The M. W. Kellogg Company.

"While Mr. Wolosewick's quotation is taken verbatim from my paper, the discussion which follows it would indicate that he has misconstrued the sense of what was said." Mr. Markl continues. "We were not concerned with establishing limitations upon loadings at pump nozzles; we merely used the suction or discharge lines to appraise the order of magnitude of expansion stresses which had been satisfactorily supported by flanged joints, not necessarily at pumps. Conditions at pumps were always given special consideration. Where the end reactions were considered excessive in relation to the design of the specific pump involved, steps were taken to absorb excess thrusts before they reached the pump.

"This is in no way intended as a criticism of Mr. Wolosewick's interesting paper, which fulfills a worthwhile function in bringing a question out into the open which confronts every piping designer, but which has not yet been answered in anything approaching a satisfactory manner. I also want to compliment your editor for his forceful statement in the 'Look Box' section, and hope that it will stimulate effort on the part of those in a position to help the situation."

Must—Three Drastic Actions

GEORGE S. BENSON, president of Harding College, gives some mighty powerful advice as to three drastic actions that the present world situation calls for the Washington administration to carry out. And forthwith:

"1) The non-military items in the federal budget should be cut to the bone. Senator Harry Byrd has offered a proposal that would trim them by $10 billion.

"2) A board of tough-minded, experienced business men should be created and given power to cut every iota of waste from military expenditures. Findings of the Hoover Commission and other revelations indicate from 10 to 20 percent could be added to the purchasing power of appropriations if waste were eliminated and sound purchasing procedure established.

"3) The state-of-war budget should be brought as nearly into balance as circumstances will permit—even if it means heavy additional taxation equitably distributed throughout the population. This action would make the full monetary cost of war and the economic sacrifices entailed painfully apparent to all Americans and thus shock them into a more active participation in the affairs of their nation."

Continuing to borrow money to finance the major portion of the war or defense effort AS WELL AS a sizeable chunk of the civilian governmental services is bad policy.

As Dr. Harding says "there is a natural tendency (on the part of the administration) to water-down sacrifices, to cater to the human weakness, to push back the hard financial facts of war's demands." We might add, particularly in election year does this tendency prevail, but election year or not, the policy is a bad one and leads a nation down a road the signboards of which might very well read "Ruin and Destruction."

LAGONDA

it's the oldest name in tube cleaning

When the first tube still was erected, Lagonda cleaners were there to take on the cleaning job.

There are fifty constructive years behind the Lagonda cleaner of today. A full half century of development, with all the grief of adventuring up false roads, all the satisfaction of real improvement achieved, that accompany successful pioneering in any equipment. This half century of invaluable experience is today bringing in big dividends to refineries everywhere where — dividends in the form of faster, more thorough tube cleaning, delays eliminated, costly minutes and hours saved in getting stills back on stream.

Put this half century of know-how to work for you. When you have a tough problem, call in the Lagonda man. No obligation.

Here is the refinery tube cleaner that half a century of successful effort has brought forth —the famous LAGONDA 1100 SERIES, ball bearing front and rear handling thrust both ways, fully lubricated in *all* bearings, and demonstrably capable of delivering coke-smashing power that only LAGONDA designed cutter heads can be expected to sustain.

Fully described in the LAGONDA bulletin, on request.

V-297

ELLIOTT Company

LAGONDA DIVISION • SPRINGFIELD, OHIO

Plants at: JEANNETTE, PA., RIDGWAY, PA. • AMPERE, N. J. SPRINGFIELD, O. • NEWARK, N. J. DISTRICT OFFICES IN PRINCIPAL CITIES

Adequate Defense Calls for Industry-Military Coordination

B. BREWSTER JENNINGS
President, Socony-Vacuum Oil Company, Inc.
New York

B. BREWSTER JENNINGS

THE broad aspects of national defense seem to be constantly changing. Probably that always will be so. Certainly the problem today so far as the United States is concerned is quite different from what it was in the years immediately preceding the two previous world wars. The important differences are all in the wrong direction. The advantages we have lost are these:

1) in the last two wars, it was wellnigh certain that the conflict would break out in Europe between two powers, or rather groups of powers, which would be sufficiently even in strength to preclude a quick victory for either.

2) the probable alliances among the combatants were such as to enable us to count on being an ally on a team which with us on their side would be stronger in manpower than the enemy.

3) those circumstances insured the U. S. time in which to prepare.

None of those favorable factors is in our defense problem now. War, if it comes, may break out anywhere, including an attack on the U. S. itself.

Our European allies of previous wars are either unarmed or hostile. Strange as it may seem, the effect of World War II was the impoverishment and enfeeblement of our strongest friends, England and France. On the other hand, Russia's power and readiness to make war appear greater than ever before, and her millions, previously on our side, must be counted on the other team now. Thus there no longer exists the balance of power that enabled us to exert decisive influence in the first and second world wars at disproportionately low cost, fearfully high though it was. That balance was destroyed when Russia's historic enemies in both the West and the East were beaten into unconditional surrender in the same year. In the next world war, if there is to be another, we seem likely to find that our enemies outnumber our allies and ourselves.

Like Russia, we could have converted our victory in World War II into great military strength. Unlike Russia, we did not. Yet, almost by default, we now find ourselves the strongest nation other than Russia. As such we block the road to world conquest. Regardless of whether we are pacifistic or belligerent, any aggressor must regard us as his No. 1 enemy. Two world wars have made it axiomatic that anyone who hopes to rule the earth must first knock out the productive capacity of the U. S. When the next attempt is made, we are not likely to have any time to prepare while our allies hold the line.

INTEGRATION exists contractually or otherwise throughout the oil industry as a result of its highly competitive nature.

Governmental assistance will be needed by the oil industry if it is to expand and meet the wartime needs of the United States, which is certain to be regarded as enemy No. 1 by any future aggressor.

An adequate defense must include the coordination of the industrial plant with the military effort.

The oil industry is thankful that the national defense setup calls for a single government authority.

These are the highlights of Mr. Jenning's talk delivered last month at the Texas Mid-Continent Oil & Gas Association meeting in Dallas and reported here with only minor deletions.

We must understand the problem of national defense before our industry can shoulder its share of the defense burden. Wars must place a tremendous load on oil, and it is necessary that oil perform 100 percent, regardless of the load.

The only fuel used by the Army, the Navy and the Air Force is oil. (This excepts the coal and electric power used in arsenals and permanent bases in the U. S., and the small amounts of missile and rocket fuels.) Increased dependence on oil marks both our agriculture and our rail transportation in the last ten years. Our farmers now own more automobiles and trucks than horses and mules. In fact they even have more tractors than teams. For our country as a whole, we estimate oil and natural gas this year will supply 59 percent of our energy requirements, compared with 44 percent in 1940.

War not only will greatly increase essential demands for oil but will create needs for specialized types, or for abnormal proportions of regular types. Reference is to the aviation needs, specifically aviation gasoline, jet fuels and special lubricating oils in the first category, and to the residual fuels used in such huge quantities by the Navy and merchant marine in the second.

While it is generally true that U. S. oil is in good shape to meet all demands, we all know that we are right now up against it to supply the top grade aviation gasoline in the volume desired, and we know that to oil a full-scale war effort will require pretty drastic rationing for civilians.

Because oil is so completely essential to the successful prosecution of war, both abroad, as we hope any war will be, and at home, where the sinews of war originate, it is important that oil be so integrated with the national war effort that our industry is not hampered, but can work as efficiently as in peace.

In January, 1949, a National Petroleum Council report as to the best kind of organization to do this emphasized that our industry is an integrated one.

Integration, whether by contract or ownership, is one of the inevitable results of competition and here's why: Pipe lines simply could not and would

ALCOA

Alcoa Heat Exchanger News

PUBLISHED BY THE ALUMINUM COMPANY OF AMERICA

HOW TO SAVE UP TO 80% ON TUBES

You can prove this to yourself. Check your local supplier—get his prices on tubes of all metals—then compare with Alcoa Aluminum Tube prices at the retail level. Foot for foot, metal for metal, you'll find Alcoa Tubes cutting your costs 30%, 50%, even 80%—depending on the type of tubes you now use. Many medium-sized refineries save $50,000 every year by switching to Alcoa Tubes.

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Alcoa Tubes allow you a wide range of operating temperatures. They easily handle steam up to 400°F. They increase in strength and show no evidence of embrittlement as temperatures drop to −320°F and below. Using Alclad Tubes, you'll have no problems from most cooling waters.

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* * *

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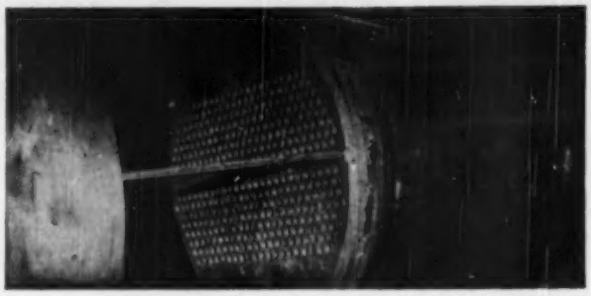
This new, 24-page booklet will answer many of your questions about Alcoa Tubes. It covers fabrication techniques . . . alloy selection . . . applications both chemical and petroleum. It describes tube cleaning, the use of inhibitors and methods of cathodic protection. It contains complete information on fluid flow and heat transfer characteristics, plus tables of physical properties and specification data. Write for your free copy, today. ALUMINUM COMPANY OF AMERICA, 1494L Gulf Building, Pittsburgh 19, Pennsylvania.



As all-aluminum heat exchanger for tonnage oxygen plant —designed and built by Stacey Bros. Gas Construction Co.

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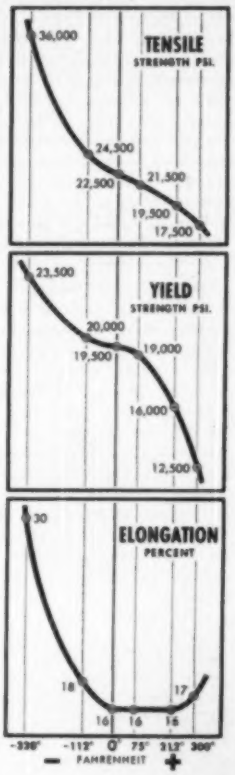
The high thermal conductivity of aluminum increases the efficiency of many types of exchangers and condensers. And best of all, Alcoa Aluminum Tubes cost far less to buy and fabricate than any other suitable metals.

Complete information is available on Alcoa Tubes for tonnage oxygen, natural gas liquefaction, nitrogen removal, dewaxing, propane chilling, ethylene extraction and many other low-temperature processes. Call your local Alcoa sales office or write: ALUMINUM COMPANY OF AMERICA, 1494L Gulf Building, Pittsburgh 19, Pa.



These three graphs show the amazing increase in tensile properties of aluminum as temperatures drop below zero.

not be built to carry a single product—oil—in a single direction unless the builders were assured a volume of traffic to make their huge investment pay out. Refineries would not be constructed unless the people putting up the money knew where they were going to get their raw material. The search for oil in the ground, and its production, seem to provide more scope for the true independent although it is doubtful whether many would assume the colossal risks of seeking oil in the far parts of the earth if they did not have an assured means of bringing it to market after they produced it.

Needed integration sometimes can be brought about without ownership. What has been taking place in recent years (and a fine thing) is the development of companies and individuals who engage in some phase of the oil industry and yet have no financial or corporate relation to other oil enterprises. Examples are companies that own ocean tankers, companies that transport oil through our inland waterways and, then, the so-called "over-the-road" oil trucking concerns. These organizations are doing a tremendous volume and doing it well. There are the thousands of jobbers, and the many more numerous dealers, who are carrying on in one branch of the industry without affiliation with any in other branches.

But no matter how it is achieved, there is integration. All of these independent units are truly integrated into the oil industry just as are dapartments or divisions of the so-called integrated companies. In most instances the independents operate under contracts which assure continuity of supply or outlet as the case may be. With few exceptions they deal only in oil. The jobber handles a few items in the tires, batteries and accessories line which are not oil, but they are relatively inconsequential.

To outlaw ownership integration would simply necessitate more contract integration. When that is understood, the politically-inspired attempts to atomize our industry by attacking the common ownership of the means of producing, transporting, refining and marketing oil appear in their true light. They are not efforts to preserve or revive competition by destroying integration because if successful they simply would substitue one kind of integration for another. They are plain, unvarnished attacks on bigness, and as such are contrary to some of the basic concepts of the profit system.

Essential Integration

Integration, whether through corporate relations, by contract or simply through state of mind, is just as essential to the strength of the oil industry as it is characteristic of it. And it is entirely consistent with the rampant competition within the industry.

There is no monopoly in oil. The public interest is being served by oil as well as by any other industry and better than by many. In a critical period such as the present, to be taking the time and effort of responsible executives to deal with suits such as the Pacific Coast case, and away from the really important job of getting on with the defense emergency, is as foolish as it is unpatriotic.

Because of the interdependent relationship of all branches of the oil business, our industry should be dealt with as a whole in coordinating it with our national defense. Only thus can optimum results be obtained. This has been emphasized more than once by the National Petroleum Council and the Defense Production Act of 1950 recently signed by the President, providing for full mobilization of industry when necessary, largely recognizes this aspect of the petroleum industry. True the bill does not follow the recommendations of the Council in all respects. Jurisdiction over tank cars, inland water carriers and tank trucks is vested in the Interstate Commerce Commission where it was in World War II. Though we would have preferred it otherwise, there are admittedly reasons why the Interstate Commerce Commission should again control these operations. If as in the last war the I.C.C. place the right kind of people in charge and accept the recommendations of the petroleum authority as to allocations there is no reason why it shouldn't work out.

Under the act the major branches of the oil industry will be the responsibility of the Secretary of Interior. At the recent NPC meeting last week, the Secretary assured the industry that the type of organization he would establish to take care of the petroleum emergency would be in accord with the integrated character of the industry. The important thing is that all the most important oil problems come under him, and we shall be acting under one authority instead of several.

As the situation is today, the Korean episode appears to be resolving itself fairly satisfactorily. Whether it will be followed by similar episodes in other parts of the world is anybody's guess. Things could quiet down and remain quiet for years; or the heat generated in Korea could ignite a devastating conflagration.

This leads to the conclusion that our consideration of oil in relation to national defense should be both short range, that is in connection with the immediate situation, and long range, with a view to placing us in the strongest possible position to meet a future crisis.

Short Range Aspects

Even with the limited Korean conflict, our industry is under considerable pressure in particular spots. We are finding it extremely difficult to make the present day military grades of aviation gasoline in adequate volume. This is primarily because alkylation plants, while perhaps too few in number, cannot be operated at capacity on a self-contained basis. There is more U. S. alkylation capacity today than is being used because in many instances the refiner owning that alkylation capacity does not produce sufficient feed stocks from his normal operations to utilize his full capacity for making alkylates. The principal aviation gasoline of World War II was 100/130 grade, requiring relatively minor percentages of alkylate, blended with good base stocks. The 115/145 grade of today requires upward of 80 percent alkylates. Though the major part of the aviation gasoline needs are in the top grade, there is a substantial need for the 100/130 grade too. Furthermore, the air lines, though requiring for the most part 100/130 grade, have wanted that grade with only 3 cubic centimeters of lead per gallon.

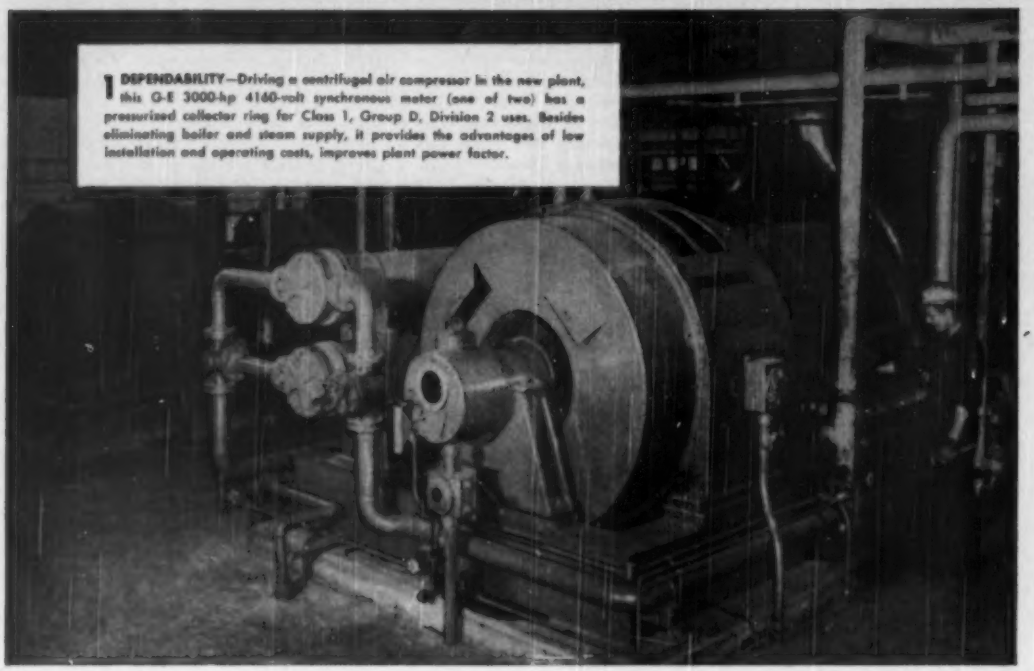
It is obvious that our industry must apart from augmenting its production of alkylate to the maximum, do everything that can be done to minimize the use of alkylate in any but the 100 and 115 grades of aviation gasoline. For the industry to do the best possible production job, several things must be done:

1) No matter who owns them or where they are locatrd, all available B-B fractions and substantial quantities of catalytic polymers must be made available to the alkylation and synthetic rubber plants. The catalytic polymers, of course, would go only to the alkylation plants.

2) Likewise regardless of who owns them or where they are located, the best gasoline base stocks must be made available for blending for aviation gasoline. Similarly all possible supplies of aromatic blending agents are required. Regardless of peacetime economics, idle plants for making these blending agents must be reactivated.

3) Assuming approval by the Civil Aeronautics Authority, maximum lead up to 4.6 cubic centimeters a gallon must be permitted in commercial aviation gasoline.

The necessity for doing these things is beyond argument. Government cooperation with the industry is perhaps the only way to effect them. There just has to be a central coordinating organization which will determine how these charge stocks will move to war production facilities, and what base stocks will be used for blending. Nation-wide marshalling of the industry's aviation gasoline and synthetic rubber manufacturing



1 **DEPENDABILITY**—Driving a centrifugal air compressor in the new plant, this G-E 3000-hp 4160-volt synchronous motor (one of two) has a pressurized collector ring for Class 1, Group D, Division 2 uses. Besides eliminating boiler and steam supply, it provides the advantages of low installation and operating costs, improves plant power factor.

Cat Cracker cracks down on shutdowns with G-E drives!

Sohio's new $11,000,000 fluid catalytic cracking plant at Lima refinery goes on stream—with co-ordinated G-E equipment helping to maintain continuous, 16,000-bbl-per-day rate!

Fluid catalytic cracking—operating as it does on a continuous basis—just can't afford shutdowns of motor-driven equipment. That's why, at Sohio's new Lima plant, the natural choice was G-E motors and control. Carefully co-ordinated to work together and stay on the job, they minimize costly plant downtime, help keep output continuous!

Whatever your process needs, G.E. can match them from the most complete line of electric equipment made for refinery service, with G-E engineers to help apply it most economically. Ask your nearest G-E office about it—*early* in your planning. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

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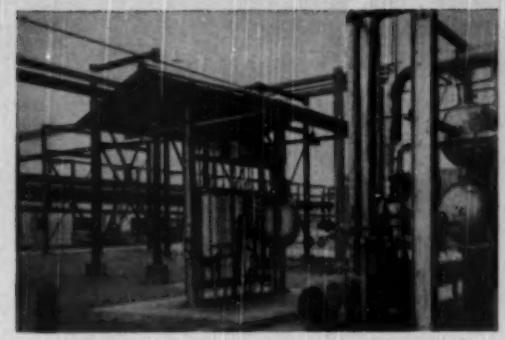
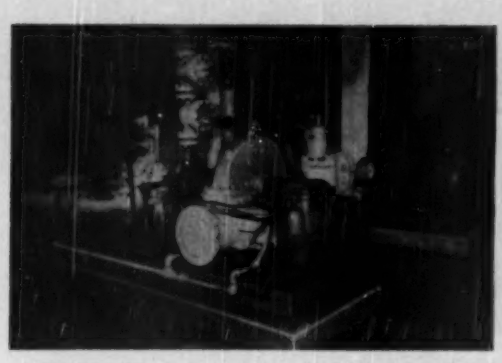


2 CONVENIENCE—A practical way to install low-voltage control in hazardous areas is to rack up an assembly of G-E combination starters and breakers, as shown here, for indoor or outdoor refinery use. They can be located close to the motors, as in this Class 1, Group D application at Sohio's new catalytic cracking plant.

3 JOB-RIGHT—Here, 7 of 14 G-E 100-hp vertical motors drive pumps that recirculate cooling-tower water. Both the motors and the G-E push-buttons mounted behind the middle motor are explosion-proof for Class 1, Group D use. G-E control for hazardous areas includes both air-break and oil-immersed types to match all G-E explosion-proof motors.

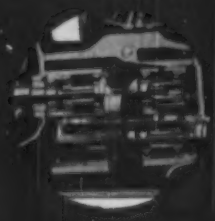


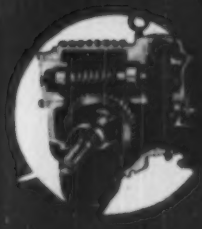
4 SELF-PROTECTED—In the pump house, this G-E Type DP mechanical drive turbine provides reliable adjustable-speed drive. Completely interchangeable spare parts plus new, standard pressure-lubrication system make these units—which operate anywhere in damp, hot, or hazardous areas—ideal for your toughest refinery applications.

5 LOW-COST POWER—In the new plant's tank field, a non-hazardous location, this G-E 750-kva outdoor load-center unit substation steps down 4160-volt power to 480 volts for use right where it's needed. These easily installed G-E units eliminate voltage drop for higher operating efficiency, cut power losses, provide flexibility for growth.

6 CENTRALIZED CONTROL—Motors driving much of the equipment on Sohio's catalytic cracking unit are controlled from a non-hazardous area, in this case the switch house, containing G-E low-voltage switchgear (left) and G-E Cabinetrol (extreme right). Made in compact, standardized units, they provide maximum personnel safety and flexibility of arrangement.

Co-ordinated
ELECTRIC EQUIPMENT
for Fluid Catalytic Cracking





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Use Master Motors to increase the salability of your motor-driven products . . . improve the economy and productivity of your plant equipment. They're the horsesense way to use horsepower.

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which adds greatly to the economy, safety, compactness and appearance of the finished product

abilities will affect all companies differently. Some will be up against it to make satisfactory motor gasoline after the cream of their components has been skimmed off. Others will be comparatively unaffected. Even if the Korean war and the resulting rearmament program do not grow beyond what is now envisioned, we shall be faced with a component allocation program and at the same time a limit on motor gasoline quality. Certainly neither of these things can come about except by government assistance and authority.

Again speaking of the short range aspects, we must welcome the provisions of the Defense Production Act that give us one authority, and then leave no stone unturned to see to it that with our help that authority does what is necessary to maximize oil's contribution to the national effort.

Steel for the industry's growing needs is certainly another major problem. Pressure tank car availability is another and will grow in importance as charging stock allocations are made. We may be in trouble on petroleum products other than aviation gasoline. Nevertheless, all these problems must be solved in the same way. We, in the industry, as well as those in government, must recognize when government action is or may be necessary for defense purposes.

Long Range Policy

The objective of a long range oil policy purely from a defense perspective would be:

To so conduct the industry in peacetime that it would be able, with a minimum of dislocation, to supply the oil requirements of the nation with products of required quality and in adequate volume wherever needed in time of emergency.

Admittedly that souds like Utopia and may be impossible but let's see where we stand today after five years of so-called peace.

Certainly we seem to be all right so far as raw material is concerned. We have about one million barrels a day of domestic crude producing capacity within the maximum efficient rate over and above current production. In other words, with domestic production in the order of 6 million barrels daily, we appear to have a potential of some 7 million, a cushion of about 15 percent.

We are in pretty good shape as to oil transportation capacities. Both crude and product pipe lines have been expanded substantially. Ocean tankers are available in much larger aggregate capacity and are better able to meet present demand than they were prior to Pearl Harbor. Furthermore, there has been a substantial increase in inland water barge capacity. We probably are not so well off in the critical field of pressure tank cars.

Our refining situation nominally looks fair. The American Petroleum Institute's statistical bulletin for July 5, estimated total domestic refining capacity at 6,737,000 barrels a day by the end of this year. We have been running about 6,000,000 barrels a day to stills, so it looks as if we had, or shortly would have, a little more than 10 percent leeway over that. Ten percent is hardly an adequate cushion in a vital branch of an industry as important to war as oil. Furthermore we all know that in any refinery the percent of capacity which is idle is the least efficient portion, and so in all fairness our true surplus is probably something less than 10 percent.

Less Alkylation Capacity

Then there is the matter of capacity for particular products or components. For instance, there is our alkylate problem. Alkylation is just one of many ways by which octanes for motor gasoline can be provided. Due to emphasis on turbine and jet propulsion, to the lack of demand for reciprocating engine aviation fuels, and to refinery economics, refineries have less alkylation capacity today than they had in 1945. Alternate methods have been more attractive commercially. Now, when the heat is on, we are reminded that alkylate is the most important way to make military aviation gasoline, and that despite the tremendous amount of motor gasoline which we have been making of a quality well above that available in any other country, we are short in ability to make what the military wants. Despite the almost complete adoption of the 115/145 grade for military planes, and the need for almost pure alkylate to make it, our industry has not only not built any new alkylation units since the war, but has actually dismantled or converted some that were in use on V-J Day.

Pressure tank cars are expensive pieces of equipment used only for a specialized trade. Nobody can afford to build and keep a surplus on sidings. So under our peactime competitive system only enough cars have been built to serve our rapidly growing liquefied petroleum gas business, etc. A national emergency will create a tremendous need for pressure cars to move B-B stocks, but little if anything has been done, or for that matter could have been done, by the industry alone to get ready to meet that need.

Should military requirements shift to jet fuels in substantial amounts, existing refinery gas plant facilities might be found entirely inadequate to meet all-out war requirements.

There are other phases of our industry where adherence to the economic stimuli of peace might leave us short in time of war.

What this all means is that, left to itself, a highly competitive industry such as ours will develop according to the pressures currently upon it, and only to those pressures. There is no extra money from earnings or any other source to permit the construction of standby capacity that would not be needed until next war, and might be obsolete then. Neither are there surplus funds to pay for equipment to make specialized products for which there is no peacetime demand.

Development On Peacetime Economics

Thus the question arises whether, in the light of all circumstances and particularly the technology of modern war with its attendant supply problems, the oil industry can be expected to be always ready to meet any conceivable wartime demands if it is to continue to rely for its development solely on the economics of peace.

I yield to nobody in my aversion to government activity in business, whether by controls, subsidies, price supports or anything else. And yet somehow the problem must be solved. Our aircraft industry is active in all sorts of work which would be beyond its financial ability based on peacetime conditions alone. Jet engines, turbo jets, high efficiency propellers and many other projects are being financed in one way or another by government, for national defense purposes. The same is true in some other industries, and even in our oil industry there is some work being done for the government in certain research projects.

It is not easy to advise means by which the building and maintenance of specialized plant, necessary for war but useless or at least inefficient in peace, can be financed. It is to be believed and hoped that there is enough ingenuity among us so that, assuming good will on both sides, appropriate arrangements can be devised.

Our problem arises out of the increasingly specialized and greatly enlarged requirements of modern war. Because of the increasing complexity of the war machine, private industry responding only to peacetime economic stimuli may no longer always be ready to meet any and all demands of sudden, total war. For the same reason the time when the armed services could be expected to provide all that they needed in the way of specialized equipment, in their arsenals, has likewise passed. An adequate defense must include the coordination of the industrial plant with the military effort. The country which does it most effectively will be the strongest.

Regimentation of business is not

PAD Designed to Protect Industry's Free Competition

An Interview With
J. R. PARTEN
Special Consultant, Petroleum Administration for Defense

MAJOR J. R. PARTEN

EDITOR'S NOTE—*Major J. R. Parten, president of Woodley Petroleum Company, Houston, and new special consultant in the formation and development of the national petroleum defense agency is particularly suitable for the task at hand, having had a varied career in both industry and government. In this interview, Major Parten gives his opinion that, barring full-scale war, the problem of adequate petroleum supply can be met by voluntary cooperation between a free, independent oil industry and the government.*

Q. *What is the Petroleum Administration for Defense and how will it operate?*

A. The Petroleum Administration for Defense is an independent government agency reporting to and taking directions from the Secretary of the Interior. It was formally set up October 3 under Secretary of Interior Oscar Chapman as its administrator, who named Hugh A. Stewart, director of the Interior Department's Oil and Gas Division, as its acting deputy administrator. PAD is a vertical setup for the industry itself, not subordinated to any other control.

Q. *Will PAD's program be conducted on a voluntary basis of cooperation with government?*

A. Yes. Secretary Chapman has made it clear that he wants the petroleum industry to do its own job with the least possible interference from government. Government will help industry do this job in several ways, by affording anti-trust clearance where necessary, by providing general coordination of the defense program, and by allocation of short materials. Just how far government will have to go depends on how critical any shortages may be. And there is nothing on the horizon now, barring full-scale war, that I consider cannot be solved by voluntary cooperation of industry and government.

Q. *Will the National Petroleum Council continue to exist and function as industry's advisory body to the government?*

A. I hope so, and there is now no plan to supersede NPC. If we should encounter full war, then perhaps NPC would be transformed into a new Petroleum Industry War Council, as in the last war, and as is the recommendation of NPC.

Q. *Will you continue to serve as consultant to the Secretary of Interior after PAD is full functioning?*

A. I shall be ready to give all assistance I can. I want to stress that the petroleum industry is the best policeman of its own job. Oil men are individualistic and are believers in a free enterprise system. The best way to be sure that our industry fulfills its obligations to the defense program is to let industry itself police the job it does. In a competitive industry like ours, that is a kind of protection you can't buy. The industry can give that protection and is the best guarantee of it.

Q. *Are octane ceilings likely on civilian gasoline?*

A. That is something that probably will take care of itself. In the building up of our aviation gasoline program it is quite possible that we may have to resort to a limitation order. A large part of the industry itself likely would want such an order. As far as the consumer is concerned, I think we could drop a few octane points without down-grading our motor fuel to a point where it would be noticed even by the automobile user. And as far as rationing of gasoline goes, there is nothing yet to indicate that such a step will be necessary.

Q. *What are the most important and immediate problems confronting PAD?*

A. They are three: avgas, steel and transportation. Perhaps avgas is our first concern right now. We are tackling that job; many alkylate plants are being reactivated, and industry is spending huge sums of its own money to get the plants back in operation. We may be able to finance that program by private money, without help from the government except for such as certificates of convenience and necessity. As for shortage of material, PAD probably will act as the claimant agency in case government action is necessary there. The transportation problem, not acute now, may become acute if the steel problem is severe. I am fully confident of the ability of the oil and gas industry to meet the tasks ahead, whatever they may be.

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Q. *What are the most important and immediate problems confronting PAD?*

A. They are three: avgas, steel and transportation. Perhaps avgas is our first concern right now. We are tackling that job; many alkylate plants are being reactivated, and industry is spending huge sums of its own money to get the plants back in operation. We may be able to finance that program by private money, without help from the government except for such as certificates of convenience and necessity. As for shortage of material, PAD probably will act as the claimant agency in case government action is necessary there. The transportation problem, not acute now, may become acute if the steel problem is severe. I am fully confident of the ability of the oil and gas industry to meet the tasks ahead, whatever they may be.

needed to get ready for war anymore than a huge standing army. Either should be regarded as a threat to the way of life we have dedicated ourselves to preserve. Our best hope of forestalling or minimizing government intervention in our business is to be prepared. Controls are the receiver who takes over when there has been a bankruptcy of foresight.

The oil industry's part in national defense should be viewed with pride and confidence, but there is no room for smugness. We made an outstanding record in two wars. Our performance in World War II under the PAW and PIWC organizations was so good that Congress has passed and the President has signed a Defense Production Act which permits the establishment of an identical set-up in a future emergency. The Secretary of Interior has given us his assurance that the petroleum agency to be established will be along those lines. Therefore, so far as the short range is concerned, we have a generally satisfactory government relationship in prospect, and now it is up to us to perform. As to the longer term, and the all-important objective of maximum preparedness to meet all military demand with minimum curtailment of requirements at home, there is some room for improvement.

EASY MAINTENANCE

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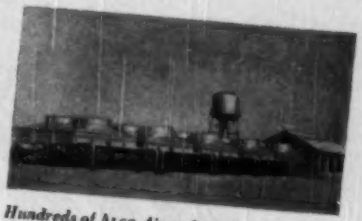
Experienced maintenance crews like ALCO Aircoolers. They will tell you that *all parts*—drives, fans, cooling surfaces, etc., are easy to reach and simple to maintain on these sturdy units.

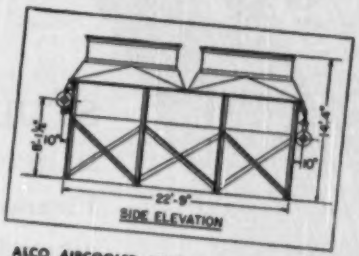
This time-saving advantage coupled with other cost-cutting "big 5" features makes ALCO Aircoolers the key to efficient heat exchange—especially where there is a lack of good water, or an expensive pumping problem is involved.

Such benefits are possible because ALCO design is based on years of in-the-field experience and years of engineering development in the production of *all* types of heat exchangers. Put the "big 5" to work in your plant. Write now for the free ALCO Aircooler booklet, or see your nearest ALCO Sales Engineer at Chicago, Cleveland, Houston, Kansas City, Los Angeles, New York or Tulsa. Plants at Dunkirk, N. Y. and Beaumont, Texas.

ONE AIRCOOLER FROM THE ALCO LINE



Hundreds of ALCO *Aircoolers like those shown are now in use cooling lube-oil, jacket-water, gas, vapors, etc.*



ALCO AIRCOOLER, MULTI-BUNDLE MODEL T-4
CONDENSED SPECIFICATIONS

No. of tubes per row—30/29 (staggered pitch).

No. of bundles per unit—Four.

Fans—Two, 10 ft. or 11 ft.

Drive—Electric Motor, V-belt or Gear Drive.

Face Area—340 sq. ft.

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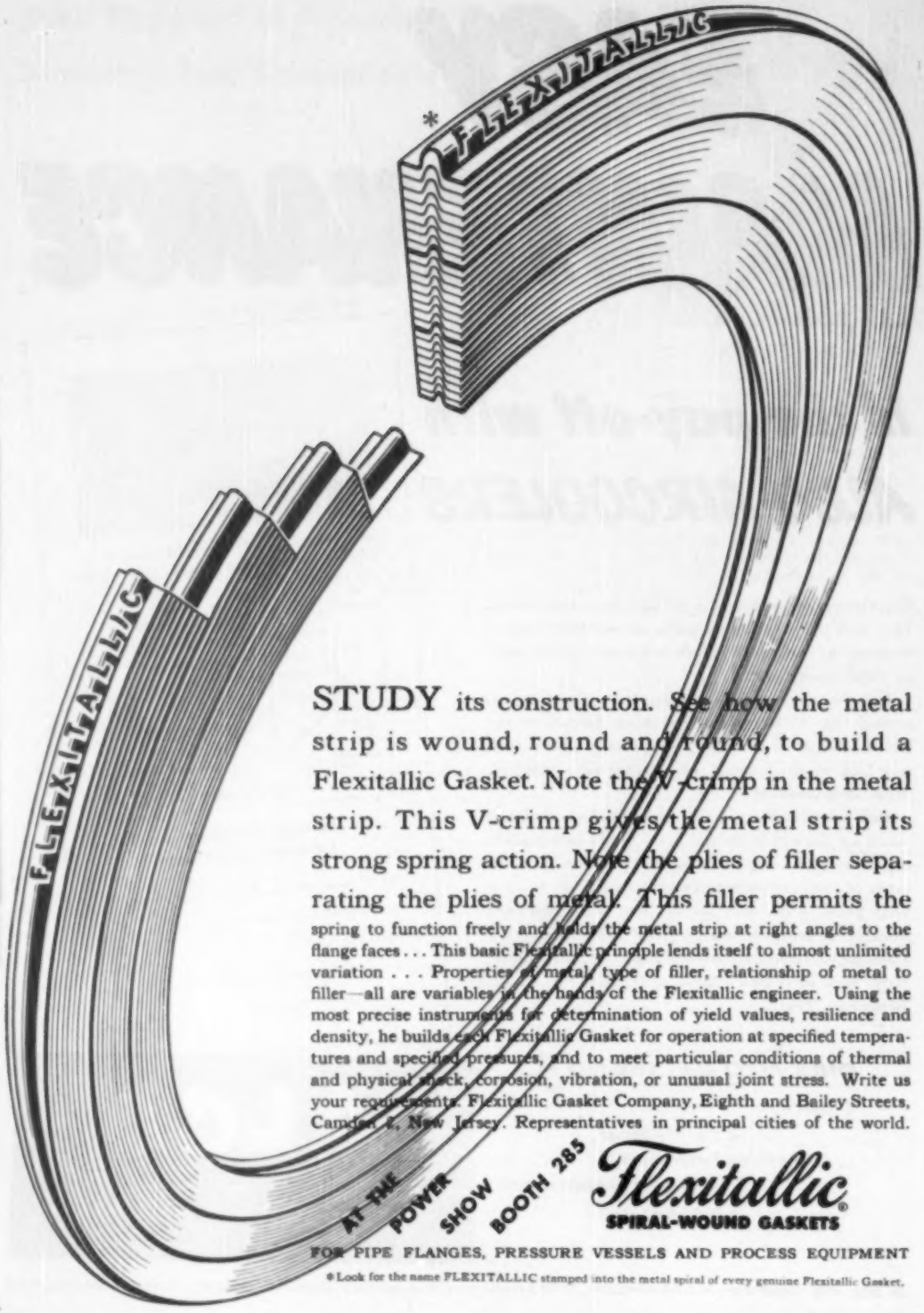

STUDY its construction. See how the metal strip is wound, round and round, to build a Flexitallic Gasket. Note the V-crimp in the metal strip. This V-crimp gives the metal strip its strong spring action. Note the plies of filler separating the plies of metal. This filler permits the spring to function freely and holds the metal strip at right angles to the flange faces . . . This basic Flexitallic principle lends itself to almost unlimited variation . . . Properties of metal, type of filler, relationship of metal to filler—all are variables in the hands of the Flexitallic engineer. Using the most precise instruments for determination of yield values, resilience and density, he builds each Flexitallic Gasket for operation at specified temperatures and specified pressures, and to meet particular conditions of thermal and physical shock, corrosion, vibration, or unusual joint stress. Write us your requirements. Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 2, New Jersey. Representatives in principal cities of the world.

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Cities Service Oil Company last month opened its new compound plant, shown at right, on the outskirts of Chicago. See detailed article, page 123.

Refinery and Other Plant Construction

Petroleum Refiner's Next "Box Score" Tabulation Will Appear in the January Issue

Onyx to Expand Refinery North of Abilene, Texas

Construction of Platforming unit and other expansion facilities will increase by 25 percent the capacity of Onyx Refining Company's plant at Abilene, Texas. The installation, estimated at a cost of $1 million, will advance the crude oil volume daily from 4250 barrels to 5500. It is expected to be completed June 1, 1951.

The new development will be on a tract of nine acres adjacent to the refinery which is eight miles north of Abilene.

Expansion facilities will include, in addition to the Platforming unit, a stabilization unit, a vacuum distillation unit, additional tankage, pumps, lines to support the enlarged operation, and a new thermal cracking still.

Construction will be under the direction of Onyx's own personnel. The designer of each unit will supervise engineering.

Construction Is Under Way On Perth Amboy Refinery

Work on California Refining Company's $30 million construction program at Perth Amboy, N. J., is expected to be completed early next year, company officials announced.

Crude running and cat cracking facilities being built at the New Jersey site will have a daily capacity of approximately 50,000 barrels.

Houdry Process Corporation and Universal Oil Products Company are licensors for the new units, and engineering is being done by C. F. Braun & Company, The M. W. Kellogg Company, Arthur G. McKee Company, and the California Refining staff. Various sections of the project are being built by Braun, Catalytic Construction Company, Utility Construction Company and Edward H. Ellis & Sons.

California Refining Company is a subsidiary of Standard Oil Company of California.

Taylor to Add TCC Unit At Corpus Christi Refinery

Taylor Refining Company has signed a contract with Socony-Vacuum Oil Company, Inc., licensors of the process, for the addition of an 8000 barrels per day modified Thermofor catalytic cracking unit to modernize Taylor's 22,500 barrels per day Corpus Christi refinery. Engineering work on the unit design has begun and construction is expected to get under way before the end of the year.

Although the charge capacity of the new modified TCC unit is only about half that of the larger units, it is now being installed in six Socony-Vacuum refineries and one plant of The Standard Oil Company (Ohio). Approximately 2000 barrels per day of cycle stock may be used to augment the rated capacity of 8000 barrels per day of fresh feed.

American Interests Build Refinery for Alberta Oil

Lake Superior Refining Company, a new company organized by W. C. Berry, Tulsa industrialist, and P. M. Lumly, president of Refinery Engineering Company of Tulsa and Chicago, has contracted with Imperial Oil Limited for Alberta crude to operate a new U. S. refinery at Superior, Wis. The refinery at Superior, eastern terminus of the recently completed Interprovincial pipe line, will supply the American Lakehead district.

A 4300-barrel per day refinery of The Carter Oil Company at Cut Bank, Mont., has been purchased by the new company, which will reassemble it at Superior. About 500,000 barrels of storage purchased from Carter also will be moved from Cut Bank to Superior.

February 15 has been set as the tentative date for delivery of the first Canadian crude, and the plant will begin operations at an initial capacity of about 5000 barrels daily. Berry said the company has already decided to increase the refinery's capacity to 10,000 to 15,000 barrels per day within 12 to 18 months, by the addition of a catalytic cracking or Platforming unit. The plant will be erected on a 100-acre site at Superior.

$5½ Million Saskatchewan Refinery Program Started

Construction has been started on the $5½ million expansion program at The British-American Oil Company's Moose Jaw, Saskatchewan, refinery. The project includes construction of a catalytic cracking unit, coking plant, thermal cracking unit and catalytic polymerization equipment, with a combined capactiy of 10,000 barrels per day.

Universal Oil Products Company is licensor for the cat cracker and cat poly units, while Process Engineers, Inc., of Dallas, is doing engineering and construction of the additional facilities. The expansion program is expected to be completed in December, 1951.

Procan Is Contractor For Johnson's Cracking Unit

Johnson Oil Refining Company has let contract to Procan, Inc., Chicago, for installation of a new cracking unit at Johnson's Cleveland, Okla., refinery.

Daily charge capacity of the cracker will be 1840 barrels, with completion scheduled for early next year. Estimated cost of the new unit is $750,000.

New Lubrizol Plant Set For Completion Next Spring

The Lubrizol Corporation's new plant near Houston is expected to be completed and start production of additives for crankcase lubricants next spring. Brown & Root, Inc., Houston, is contractor for the $1 million plant.

Only a few key employes will be transferred to Houston from Lubrizol's Cleveland plant, where capacity is also being enlarged. The company's research

and engineering laboratories will continue to be centralized at Cleveland, and the Houston plant will be solely a production operation.

Premier Is Constructing Cat Cracker at Fort Worth

Construction has been started on Premier Oil Refining Company's $750,000 catalytic cracking unit at the company's Fort Worth refinery. Universal Oil Products Company is building the plant addition. Note picture at right.

The new unit will be used chiefly for the reforming of straight run gasoline processed by Premier's other refineries at Arp, Baird and Longview, Texas. Capacity of the unit, which is expected to be in operation early next year, will be 1500 barrels a day.

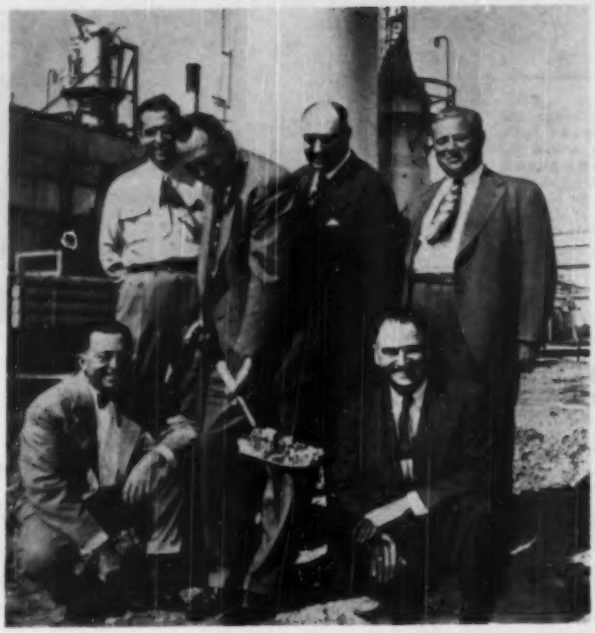
Sinclair's New Venezuela Refinery Goes on Stream

Sinclair Oil & Refining Company has begun operations at its new 35,000 barrels per day refinery at Puerto de la Cruz, Venezuela, adjacent to the company's crude oil loading terminal on Chaure Bay.

Santa Barbara type crude processed by the plant is supplied through a 110-mile, 50,000 barrels daily pipe line from Santa Barbara field connecting with other East Venezuela producing areas.

Facilities at the new plant includes a modern topping still with heater, a flash tower, fractionating column and stripping tower. Gasoline, kerosine and diesel oil treating plants, as well as an ethylizing plant, have been installed.

Available at the refinery are 2,200,000 barrels of storage for crude and products, of which 1½ million barrels capacity is new.



PLATFORMER FOR TEXAS—Ground was broken last month for the installation of a new UOP Platforming unit at the Fort Worth refinery of Premier Oil Refining Company of Texas.

The 1500-barrel-per-day unit, the first Platformer in Texas, designed by Universal Oil, will be used chiefly for reforming of straight-run gasolines produced at Premier's refineries. The new plant is expected to be in operation early in 1951.

Shown in the photograph are, left to right, kneeling: L. G. Dufilho, general superintendent of Premier refining operations who will supervise the construction work; and Elmer Smith, superintendent of Premier's Longview refinery. Standing: L. B. Connelley, refinery superintendent at Fort Worth; President R. P. Hargis (with shovel); N. Y. Jones, administrative refinery superintendent at Arp; and J. E. Bullock, administrative refinery superintendent at Baird.

TEXACO RESEARCH UNIT—Recently completed, the brick-faced building, above, affords 55,000 square feet of added research area and increases by approximately 40 percent the facilities of The Texas Company's main research center, the Beacon, N. Y., Laboratories. Design of the new structure permits maximum flexibility in the use of the laboratory space. It is laid out in ten-foot basic floor-space sections with movable metal partitions in all areas. According to Dr. W. E. Kuhn, Manager of Texaco's Technical and Research Division, the design of the building was chosen to best fulfill Texaco's needs after intensive studies were made of other industrial laboratories.

"This investment further substantiates Texaco's firm belief in private research free from the restraints of public subsidy," he added.

Perco Unit To Be Built At Permolio's Milan Plant

Permolio, S.P.A., Raffinerie Italiane Olii Minerali is constructing a Perco reforming unit with a capacity of 350 barrels daily at its Milan, Italy, refinery. The unit is said to be the first of its kind in Europe.

The Perco unit is expected to be completed and in operation early in 1951.

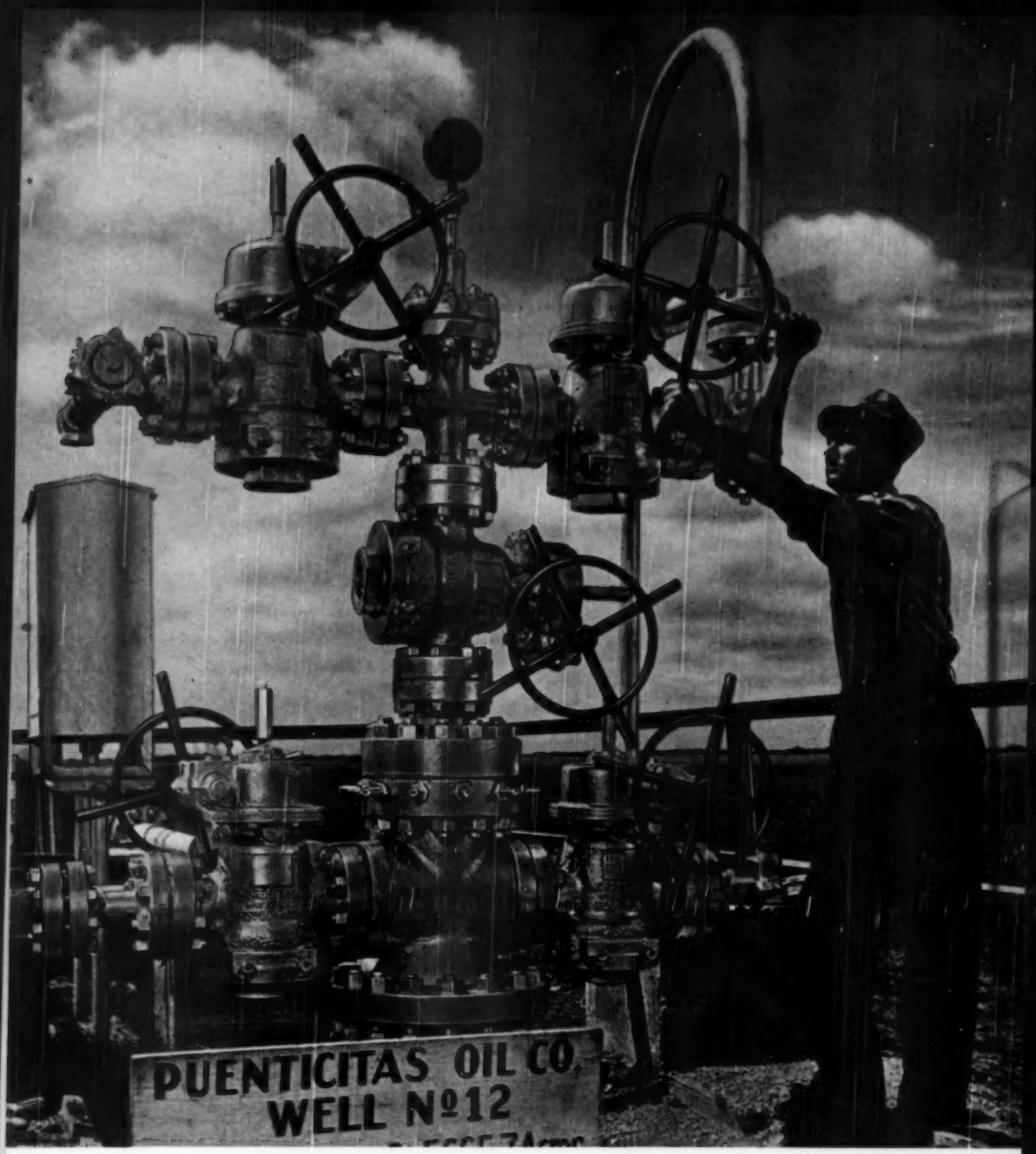
Permolio had earlier announced plans for adding catalytic cracking units, each with a capacity of 1630 barrels daily, to its Genoa and Rome Refinery installations.

Light Oil Plants Planned

The Chemical Plants division of Blaw-Knox Company has received contracts for two plants to recover light oil from high Btu. gasoil. The plants will be erected in Massachusetts for Cambridge Gas Light Company, Cambridge, and New Bedford Gas & Edison Light Company, New Bedford.

Addition at Deer Park

Shell Chemical Corporation is constructing an alcohol denaturing unit at its plant at Deer Park, Texas. Pioneer Industrial Company is contractor for the project.



It's a pleasure to operate a Nordstrom valve. Smooth rotary movement instead of dragging action across seat rings insures easiest operation. An entire battery of Nordstroms can be opened or closed within a few minutes, in contrast to hours for some other types. There's no tug or toil to tighten or "break open" a Nordstrom, because the rotary, tapered plug is seated on lubricant, sealed by lubricant and jacked by lubricant.

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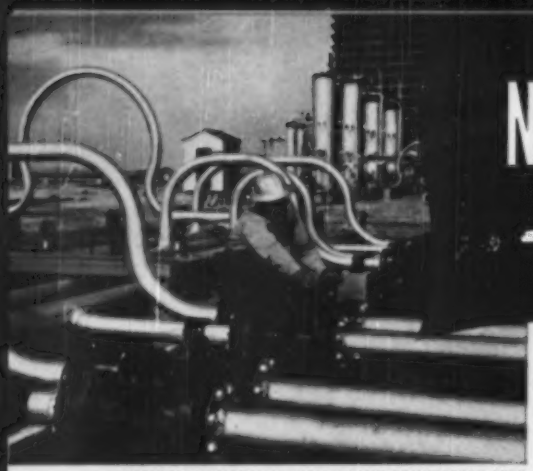
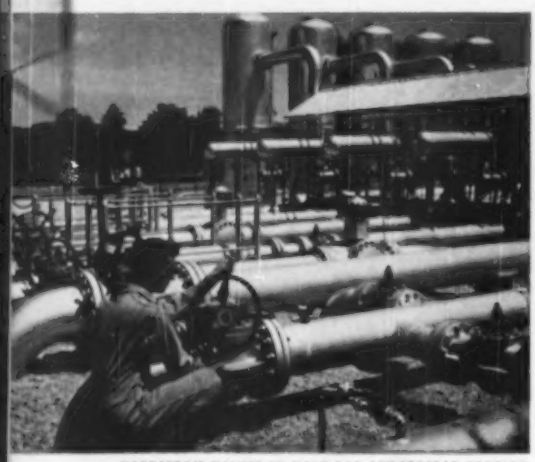


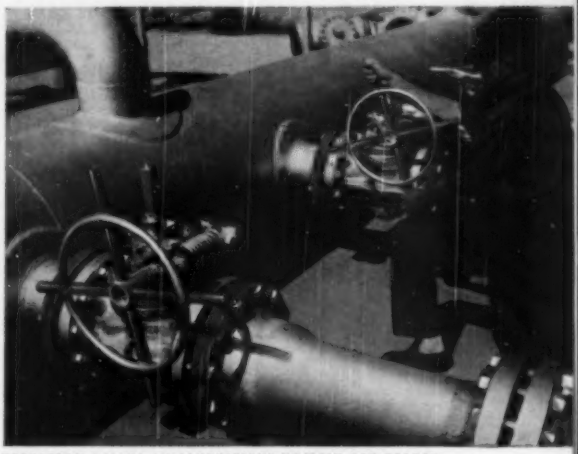
NORDSTROM VALVES IN FIELD PLANT COMPRESSOR LINE

FIELD PRODUCTION MANIFOLD, NORDSTROM EQUIPPED



NORDSTROM VALVES IN MAIN GAS COMPRESSOR STATION

NORDSTROM MUDLINE VALVES ON OFF-SHORE DRILLING BARGE



NORDSTROM VALVES ON CONNECTIONS TO MAIN GAS HEADER

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PETROLEUM
REFINER
NOVEMBER, 1950
Volume 29 No. 11

Sweetening and Desulfurization Of Light Petroleum Products

V. A. KALICHEVSKY
Consulting Chemical Engineer,
Magnolia Petroleum Company, Beaumont, Texas

Part I—Introduction

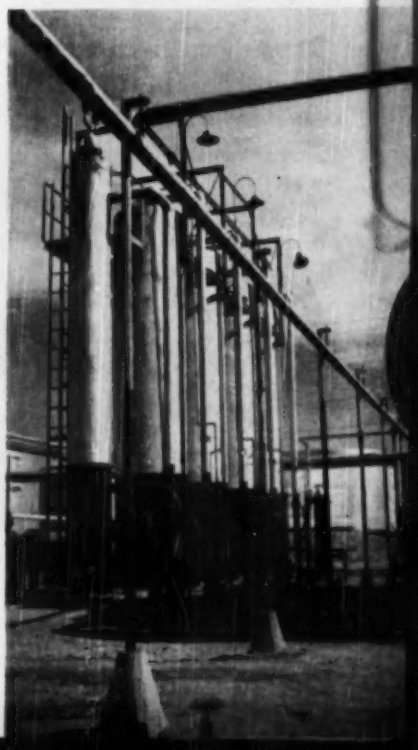
THIS IS the initial article of a series that will present a rather complete study of the chemistry and treating procedures employed by refineries making gasoline and other light distillate products from sulfur bearing crude oils. It is generally known that the average sulfur content percentages of our crude oils are increasing. Also, swollen demands for petroleum products now encourage the processing of stocks once neglected as not offering profitable operations. One result of these circumstances is an increasing number of process plant difficulties, both from the standpoint of making products of satisfactory specification and performance, and from the standpoint of plant operating costs. Most of the problems are not new, but in the past they have been encountered more rarely and in lesser degree.

The basic series will deal primarily with chemical and process considerations. The varied nature of the sulfur compounds occurring in petroleum and the number of treating systems in use will require a fairly lengthy report for adequate coverage. There will not be sufficient space for detailed descriptions of treating plant equipment and mechanical construction. Too, the inclusion of such details would greatly complicate the discussion of chemical considerations and would lead to pointless repetitions. The physical details of these plants are important, however. Accordingly, they will be described in a separate but parallel series of articles. The first of these articles on the mechanical design of treating plants will present a typical plant used for the "doctor" treating of gasolines. It will appear in the same issue with the section of the series on the chemistry of treating, Part III, "Sodium Plumbite Treatment."

THE problem of desulfurizing and eliminating the presence of objectionable sulfur compounds associated with the petroleum distillates is almost as old as the petroleum industry but up to now no solution has been found which would satisfy everybody's wishes. The importance of the problem varies with the type of crude oil processed, commercial equipment available and types of products manufactured by a refinery. In this country the situation is most acute in California while some of the eastern plants handling Pennsylvania crudes may not even be cognizant of its existence. Recent surveys showed that both the absolute and relative volumes of high sulfur crude oils produced in the United States increased considerably over the last several years[23] which should be interpreted as a warning that removal of sulfur from petroleum products is not a temporary but a lasting problem of major interest to a large number of refineries.

The effect of the presence of sulfur compounds on quality of various petroleum distillates is discussed at length by Kalichevsky and Stagner.[14] Specifications covering such distillates sometimes refer both to the total sulfur content and to the content of certain sulfur compounds, notably mercaptans, which are considered particularly objectionable. These specifications are by no means always justified and are often inherited from the past when the knowledge of petroleum was in its early stages of development.[9] In most instances product performance has little if any connection with the sulfur content of material and is much more reliably evaluated by tests that have a closer relationship to actual service conditions than approximated from the sulfur content of the product. For instance, the quality of kerosine is best established by its ability to pass the burning test. If the test is satisfactory it is somewhat difficult to justify rejection of a sample of this material merely on the basis of its high sulfur content. The same considerations apply to the old Federal specifications of 0.1 percent maximum sulfur content in gasoline. Although these specifications were abandoned some of the communities are still considering them, forgetting that they were developed at the time when the available information on the subject was inadequate. Specifications were adopted under an erroneous presumption that the presence of sulfur in motor fuels is undesirable and then only after a general survey revealed the possibility of manufacturing such low sulfur content fuels without undue hardships to the customers and industry. Since that time conditions changed considerably. Many millions of barrels of gasoline having sulfur contents between 0.2 and 0.5 percent were marketed in the Western United States without harmful effects[10] while in

Typical Installation for Gasoline Treating by a Copper Sweetening Process.



Europe motor fuels containing even greater quantities of sulfur showed satisfactory performance.[14] Corrosion formerly ascribed solely to the presence of sulfur dioxide in the products of combustion was found to be caused primarily by condensation of moisture in the crankcase at low operating temperatures. It is of interest that the presence of sulfur in some of the petroleum products may be beneficial. For instance the diesel index is raised on adding some of the sulfur compounds to fuels.[13,24]

TABLE 1

Desulfurization of Petroleum Products by Heating in the Presence or Absence of Heavy Hydrocarbon Materials

Desulfurizing Medium	U.S. Patent	Date	Inventor
Asphalt	414,601	Nov. 5, 1889	Stevens, L.
Drying oil	1,703,616	Feb. 26, 1929	Egloff, G.
Heating	906,400	Dec. 29, 1908	Eggleston, J. E.
	1,018,040	Feb. 20, 1912	Eggleston, J. E.
	1,018,374	Feb. 20, 1912	Robinson, C. J.
Heavy cracked oil	1,215,732	Feb. 13, 1917	Snelling, W. O.
Naphthalene	1,125,422	Jan. 19, 1915	Whitmore, S. W.
Steam	306,734	Oct. 21, 1884	Friedburg, L. H.
	486,406	Nov. 15, 1892	Huston, J. B.
	556,155	Mar. 10, 1896	Lowe, W. F. and Billinger, C. W.
Steam or air	129,014	July 16, 1872	Farrar, A.
Steam and air	415,876	Nov. 26, 1889	Minshall, F. W.
	439,745	Nov. 4, 1890	Edwards, E. A.
Steam and vacuum	232,685	Sept. 28, 1880	Clark, E.

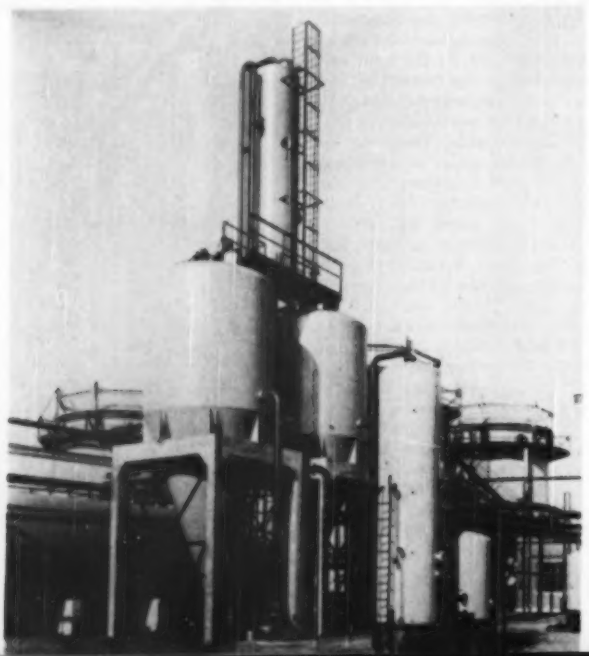
The sulfur problem in the case of gasoline with which the present articles are mainly concerned, acquired some additional aspects which were practically non-existent a few decades ago. Since that time the importance of antiknock properties of gasoline has been well recognized and tetraethyl lead became a common ingredient in many motor fuels. A number of investigations has been made which led to the conclusion that sulfur compounds may have a deleterious effect both on octane rating and lead susceptibility of gasoline.[5,16] In this respect not all of he sulfur compounds are alike but in some instances addition of as little as 0.01 percent sulfur in one of its most active forms to an aviation fuel containing 4.8 c.c. of tetraethyl lead per gallon may lower its octane number by as much as nine points.[8] Attempts were made to grade sulfur compounds according to type on the basis of their undesirable effects on this gasoline property. In one of such studies various sulfur compounds were added to a synthetic fuel consisting of 60 percent iso-octane, 40 percent normal heptane and 3 c.c. of tetraethyl lead per gallon. The worst offenders were found to be alkyl tetrasulfides, followed by mercaptans, primary alkyl disulfides, alkyl sulfides, elementary sulfur and thiophenes in the order mentioned.[17] Some mathematical relationships were derived for estimating the effect of some of these sulfur compounds on the octane number of leaded fuels[1,18,22] but a certain amount of caution should be exercised in applying them to the solution of practical problems.[12] This is easily explained by the fact that averages do not exist in nature and compounds belonging to one chemical group may vary in their characteristics within wide limits overlapping those of the compounds related to some other chemical group.

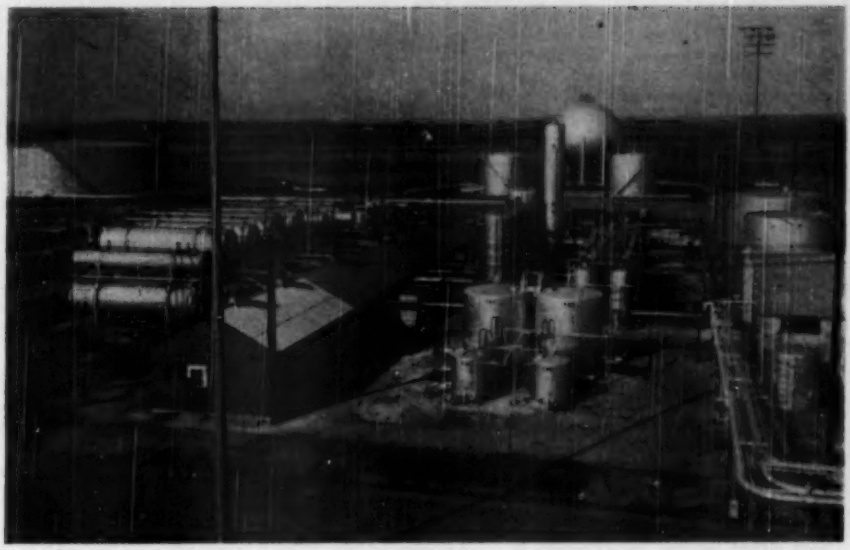
In general the effect of sulfur compounds on antiknock rating of gasolines free of tetraethyl lead is quite pronounced after addition of the first small increment of these compounds to the oil. Beyond this critical quantity the change in the octane number is barely noticeable even when the total amount of sulfur compounds introduced into the fuel is five and more times greater than this amount.[5] The observed variations in antiknock ratings of gasolines of zero and 0.01 percent sulfur content is seldom over one or two points on the octane scale and remains practically unchanged after the sulfur content is raised to 0.05 percent or higher. However, with the leaded fuels the loss in the octane number is much more proportional to the quantity of sulfur compounds present. For this reason in refinery operations an economic balance should be established between the cost of desulfurizing gasoline to various levels and the corresponding savings effected by the decreased quantities of tetraethyl lead required to produce the specification fuel.

Sulfur compounds present in petroleum products are not necessarily identical with those found in the crude oils. Radical changes in their structure often occur in the course of refining and new sulfur containing substances may be formed by the interaction of some of the sulfur compounds with hydrocarbons and other materials originally associated with the oil. In this respect sulfur compounds are no different from others and the relatively meager information available on this subject is explained by the experimental difficulties encountered in studying such reactions rather than in lack of their variety.

On heating the crude oil more or less large quantities of hydrogen sulfide are evolved which arise from the decomposition of the less stable sulfur compounds present in the natural products. Evolution of hydrogen sulfide increases with the increase in temperature to which the oil is exposed and the length of time the oil is heated. The total sulfur content of the liquid products thus shows a decrease and, for this reason, desulfuri-

Light oil sweetening process uses cupric chloride for converting malodorous mercaptan sulfur compounds into compounds with a more marketable odor. Oxygen is used for treating reagent regeneration.





General view of Gasoline Treating Unit. (Courtesy Linde Air Products Company.)

zation of oils may be assumed to begin from the time when the crude petroleum is charged to the stills although in many instances the observed reduction in the sulfur content may be barely noticeable. Distribution of sulfur in thermally[2] and catalytically[10] cracked products as well as in straight-run naphthas[7] has been the subject of several investigations and catalytic cracking was shown to be an excellent desulfurizing process.[26] At high cracking levels, however, evolution of hydrogen sulfide may be less than that observed at the lower levels although the sulfur content of the gasoline may continue to decrease. This is explained by the reaction of sulfur with the heavy products of cracking[21] withdrawn as coke or heavy residuum. The nature of the involved phenomena is rather obscure while the literally infinite number of possible chemical transformations which may occur between the multitude of compounds present in the crude oil makes such studies extremely difficult if not impossible by the existing analytical methods.

The ability of heavy petroleum residues to retain some of the sulfur compounds present in the light distillates has been observed many years ago but the wide adoption of desulfurizing procedures, based on these observations, has been discouraged by the relatively small degree of sulfur removal which can be accomplished in this manner. Table 1 refers to some of such processes recommended in the past.

Composition of crude oils handled by the individual refineries is by no means constant. Considerable variations are observed even between the crude oils arising from different wells within the same oil fields. For this reason each refinery has a sulfur balance of its own which undergoes changes with the type of equipment employed, method of running it and similar factors. With these reservations it appears that on thermal cracking the major portion of the sulfur remains in the fuel oil.[9] On thermal reforming of straight-run naphthas their sulfur content might be reduced by one-half or even more while gasolines obtained by catalytic cracking normally contain only a very small quantity of sulfur compounds. On the other hand, gasolines produced as by-products in viscosity breaking of residual oils are well known for their high sulfur content.

On refining oils with chemicals sulfur compounds like hydrogen sulfide or mercaptans may react under favorable conditions with the unsaturated hydrocarbons[11] or other pertoleum constituents. Treatment of thermally cracked gasolines containing hydrogen sulfide and unsaturated hydrocarbons is conductive to formation of mercaptans.[27] Other condensing agents beside sulfuric acid may yield similar products.[4] New compounds may arise from interreaction of olefins and sulfur dioxide evolved in sulfuric acid refining.[15,25] Thiophenes may be absent in the charge stock but appear in the distillation products.[20] Nitrogen compounds my be involved in the reactions and the theoretical possibilities leading to the formation of new sulfur compounds may be multiplied almost infinitely as indicated in the treatise on organic chemistry.

The obscure nature of many sulfur compounds associated with petroleum explains a rather loose nomenclature often employed by petroleum chemists. Chemical names are assigned without proper justification and for this reason it is always helpful to know the analytical procedure employed in identifying the compounds in order to avoid possible misunderstandings. Sulfur compounds which frequently occur in petroleum and its products and which are more or less easily identified may be enumerated as follows:

Elemental sulfur may be present because of oxidation of hydrogen sulfide associated with the oil by atmospheric oxygen. In many instances its appearance in the petroleum distillates can be avoided by eliminating hydrogen-sulfide from these distillates before it is given sufficient time to oxidize. Elemental sulfur is corrosive and its presence is generally undesirable.

Hydrogen sulfide is normally associated with crude petroleum and is evolved in considerable quantities during distillation as it was already mentioned. It can be easily separated from the oil because of its low boiling point (—79.2° F.) and distinctly acidic properties.

Mercaptans also known as thiols or thioalcohols, are probably the most advertised sulfur compounds associated with petroleum products. Their presence is easily detected by simple chemical tests which might be partly responsible for their notoriety. The lower members of the series have dis-

agreeable odors but this is not necessarily true with the high members some of which are used in perfumery. Mercaptans affect unfavorably lead susceptibility, corrosiveness, color stability and some of the other gasoline properties. However, these properties are evaluated by direct tests thus making more or less superfluous the tests for mercaptans in product specifications.

Sulfides or thioethers are relatively stable sulfur compounds and are rather inoffensive subject only to the general considerations applicable to all sulfur compounds.

Disulfides are produced by oxidation of mercaptans. They are present in all gasolines from which the mercaptans are eliminated not by removing them completely but by oxidation reactions. This requirement seems somewhat strange because disulfides are not less offensive than the corresponding mercaptans with respect to their effects on lead susceptibility or color stability of petroleum products. For this reason the modern refining methods attempt removing mercaptans from the oil instead of converting them to disulfides.

Polysulfides are formed on oxidizing mercaptans to disulfides in the presence of excess sulfur. They are corrosive and the degree of corrosiveness increases with the increase in the number of sulfur atoms in the molecule.

Thiophenes are not considered to be offensive sulfur compounds and their presence is tolerated subject to the general considerations applied to all sulfur compounds.

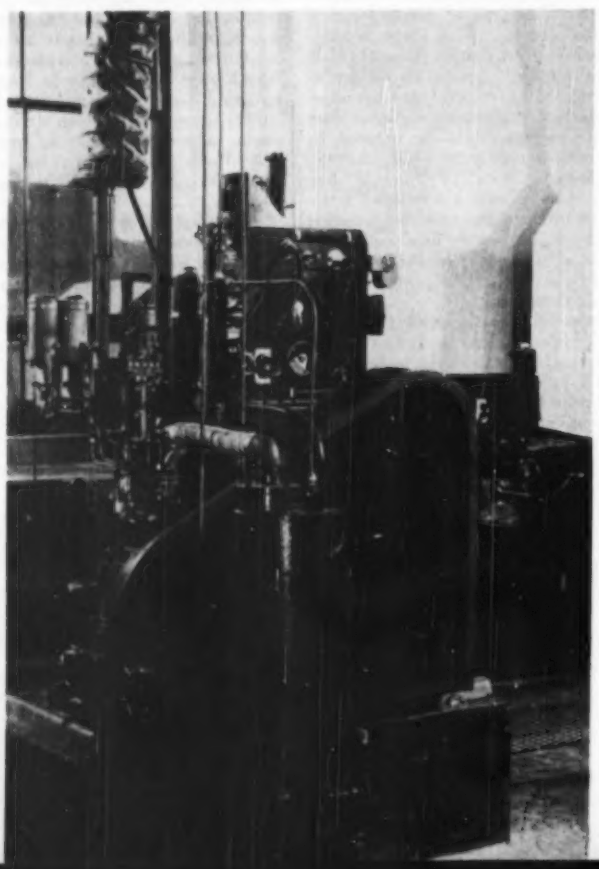
Thiophanes are difficult to detect and the term is often applied rather loosely to cover all sulfur compounds of unknown structure which do not respond to analytical tests for typical sulfur compounds.

In addition to the above mentioned sulfur compounds sulfur bearing substances may be formed in the course of refining through interreaction of hydrocarbons with the sulfur containing reagents such as sulfuric acid. These substances include sulfuric acid esters, sulfonic acids, sulfones and others and their presence in the refined petroleum products is often explained by the improper application of refining agents.

The methods employed in treating the sulfur bearing oils are of two distinct types. Some of them merely change the structure of sulfur compounds leaving the total sulfur content unaltered while others actually remove them from the oil. In the first instance, which covers oxidation of mercaptans to disulfides, the overall improvement in product quality is frequently doubtful, while in the second case difficulties may be encountered in finding cheap reagents which would accomplish desulfurization without high treating losses. These losses may be caused by side reactions involving other than sulfur compounds or in the case of some high sulfur distillates the quantity of sulfur compounds present may be so high that they actually constitute an appreciable portion of the raw stock. For this reason the preferred methods would be those which can eliminate sulfur from the molecules without destroying them completely.

(End of Part I. Part II will appear in an early issue.)

Sulfur contamination in motor fuels tends to increase lead requirements for given octane levels. An economic balance should be struck between desulfurization costs and savings effected through decreased quantities of tetraethyl lead.



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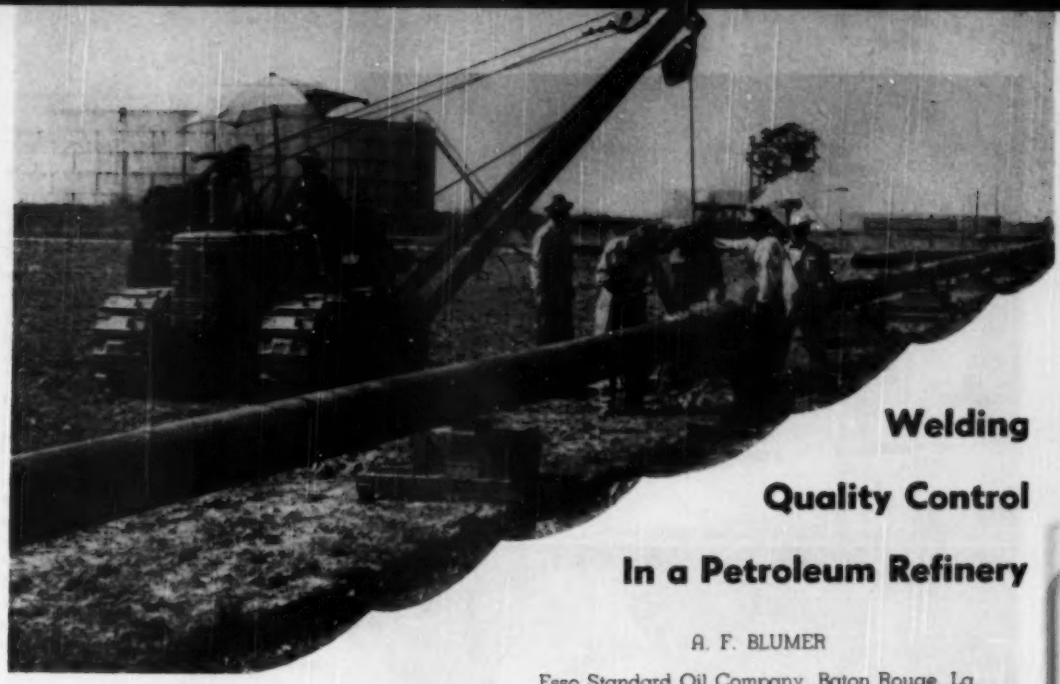


Figure 1. Field Pipe Welding.

Welding Quality Control In a Petroleum Refinery

A. F. BLUMER

Esso Standard Oil Company, Baton Rouge, La.

A LARGE petroleum and chemical refinery is a complex system of processing equipment, piping, and tankage. All of this must be maintained in safe and efficient operating condition and much of the maintenance requires welding. A large variety of welding applications is encountered. In the interest of obtaining high quality strength welds and performing welding in the most efficient and economical manner, welding quality control must be exercised. Welding quality control consists of qualification testing of welding operators, continued sampling and welding inspection on jobs in progress, testing and selection of suitable electrodes, adherence to carefully developed welding procedures and job specifications, and evaluation and use of applicable new developments in the field of welding.

Original presentation was before the 1950 ASME Petroleum Division Conference, New Orleans, September, 1950.

IN A DISCUSSION of welding quality control in a petroleum refinery, it is perhaps better to approach the discussion by first outlining the types of welding encountered in the refinery and over which quality control must be exercised.

The Baton Rouge refinery, first put into operation in 1909, contains eight crude distillation units, three catalytic cracking units, three alkylation plants, two phenol treating plants for lube oil manufacturing, several types of lube oil dewaxing plants, and units for the manufacture of alcohols, synthetic rubbers, and synthetic rubber raw materials. Associated with these units are many other process units for finishing the base stocks produced, for the production of certain of the feed stocks used, and for the manufacture of other products such as asphalts and greases. Tankage must be provided for the feed stocks, intermediate stocks, and finished stocks, and there are many millions of feet of piping connecting all of this equipment.

All of the process equipment, tankage, and interconnecting piping must be periodically maintained and much of this maintenance will require welding. At the present time, there are 96 welders not including the supervisory personnel, 88 of these are metallic arc welders and eight are acetylene welders. In addition to the refinery welding personnel, there are 13 welders employed by contractors performing some type of work in the refinery.

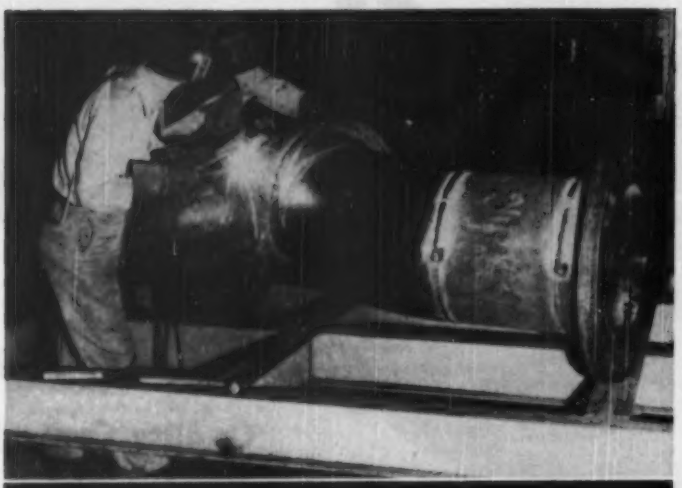
Pipe Welding

Pipe welding probably constitutes the major portion of the welding operations in the refinery. Figure 1 illustrates welding being performed on a field pipe installation. As much as possible, pipe work for the units is handled on a prefabricated basis. Figure 2 illustrates a typical shop fabrication job on a complex manifold.

While the vast majority of the pipe welding is performed on carbon steel piping, some alloy pipe welding is also done. This type of welding, however, will be discussed more fully under "Alloy Welding."

Plate and Structural Welding

Plate and structural welding probably constitutes the second largest single phase of welding operations. Figure 3 illustrates alterations being made to a pressure vessel in the shop. Figure 4 shows a shell of a heat exchanger being fabricated in the shop. Figure 5 shows the installation of a 24-inch manhole in a pressure vessel in the field. In this particular installation, the plate thicknesses were such that stress relieving was required. This thermal stress relieving was performed in the field by the use of a gas burner ring, and it was at this stage of the



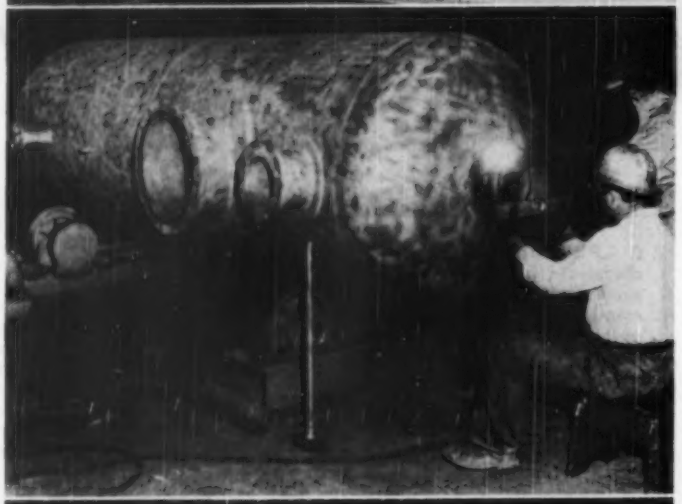


Figure 2. (Top) Shop Pipe Fabrication.

Figure 3. (Center) Altering Pressure Vessel.

work that the picture was actually taken.

On some of the process units, the vessels are too large for shipment by rail and in these cases they are fabricated in the field. This particular type of work may be handled by contractors' welders as well as by refinery welders. Figure 6 shows a 16½-foot diameter by 125-foot high tower which was field fabricated.

Structural welding also constitutes a large phase of welding operations. In this particular field, supports and platforms are included. In some cases, the structural steel of building frames is also welded. Figure 7 illustrates a welding operation which would not normally be associated with a petroleum refinery. This figure shows the construction of a rudder for one of the river tow boats. On this job, the steel plates and structural members were precut in the shop and the pieces assembled at the river.

Storage Vessels

Another phase of welding which constitutes a rather large field is the erection and maintenance of atmospheric and pressure storage vessels. Figure 8 shows repairs being effected on a storage tank. On this tank, the top shell ring, internal structural steel, and roof are being renewed. This particular job is being handled by contractors' welders, but on many occasions may be done by refinery welders. The liquefied petroleum gases must be stored under pressure and this is usually accomplished in spheres or spheroids. Figure 9 illustrates the field erection of a sphere.

Alloy Welding

Corrosion constantly presents a serious problem in refining operations and is combatted through chemical means intended to neutralize the corrosive agent or through the use of alloy materials which are resistant to the corrosive agent. In some cases, strength requirements such as for extremely cold or extremely hot services demand the use of alloy materials. Corrosion and service conditions have led to the use of such alloy materials as killed carbon steel; high carbon steel; carbon molybdenum steel; 5 percent chrome; 9 percent chrome; 13 percent chrome; 18-8 chrome nickel in types 304, 316, and 347; 25-12 chrome nickel; 25-20 chrome nickel; Durimet; Worthite; Hastelloy B and D; monel;

Figure 4. Fabrication of Exchanger Shell.

Figure 5. Installation of 24" manhole.

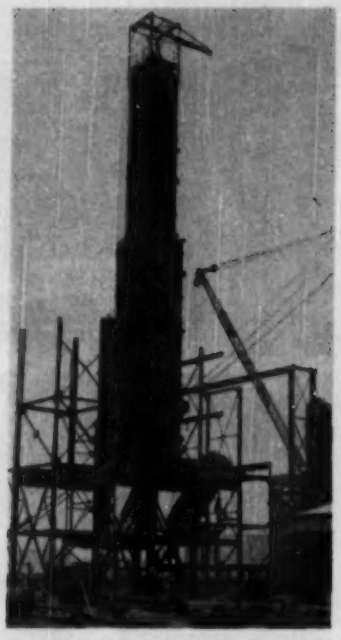


Figure 6. Field Fabricated Tower.

commercial nickel; low nickel steels (approximately 1 percent); 3½ percent nickel steel; Cyclops; many of the brass alloys; copper; aluminum; Inconel; lead; and hard surfacing materials, such as Colmonoy, Stoodite, and Stellite. Clad materials where steel sheets are surfaced in monel, nickel, and 18-8 chrome nickel are also frequently used. Figure 10 shows a section of 48-inch piping fabricated from 18-8 chrome nickel which the welder is just finishing. This particular section is for one of the lines on a catalytic cracking unit.

Figure 11 illustrates the plug welded type of liner in which alloy sheets about 3/32-inch thick are welded to the steel vessel wall through drilled or punched holes. Figure 12 illustrates a strip welded alloy liner in which strips are installed in shingle fashion to the vessel wall. Figure 13 shows the field installation of a strip welded Inconel liner in a crude distillation tower.

In small pieces of equipment where corrosion resistance is required, alloy liners which are built up by welding are frequently used. Figure 14 shows the installation of a welded Hastelloy B liner in a centrifugal pump.

A small amount of alloy welding in the form of hard surfacing is encountered in the refinery. This is principally confined to such things as pump sleeves and pump parts for reciprocating and centrifugal pumps. Hard surfacing materials such as Colmonoy, Stoodite, and Stellite have been used. Figure 15 shows the application of a hard surfacing material on the screw of a screw-type positive displacement pump handling powdered catalyst.

Welders' Qualification Tests

Welding quality control unquestionably begins with the employment of the welder. Every welder employed by the refinery and every welder employed by a contractor working in the refinery is required to demonstrate his ability to perform satisfactorily welds of the quality demanded through a qualification test.

It is the endeavor in refinery welding operations to create versatility and steer away from specialist in any particular type of welding. Welders must be equally good on pipe work, vessel

Figure 7. Ship's Rudder.

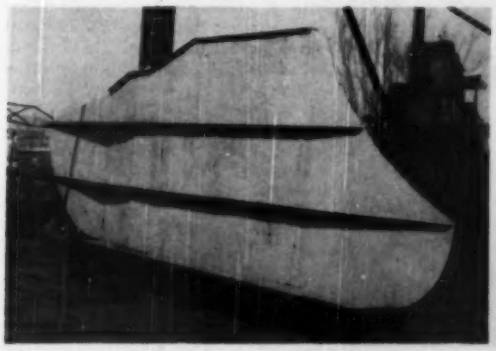
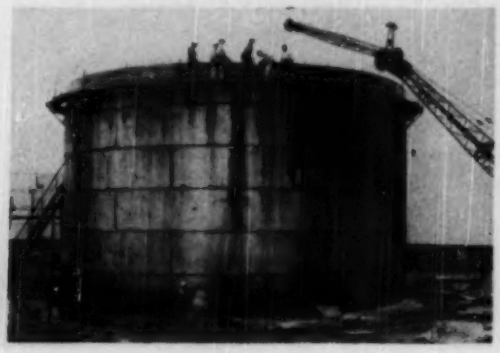
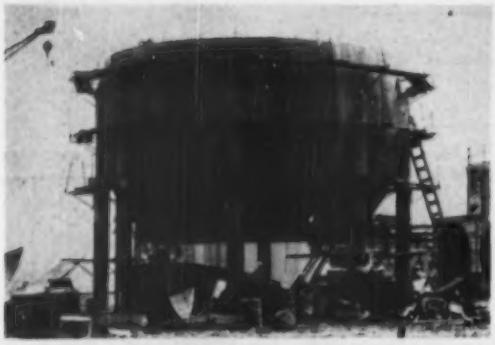


Figure 8. Repairing Tank.





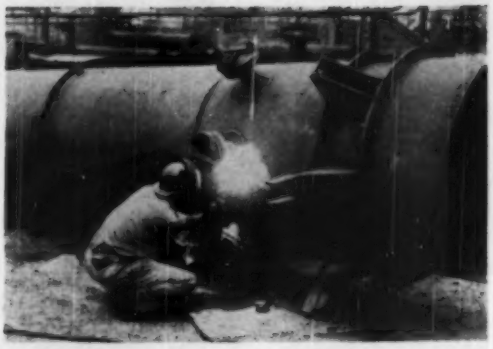


Figure 9. (Top, left.) Erecting Sphere.

Figure 10. (Top, right.) 48-inch Alloy Line.

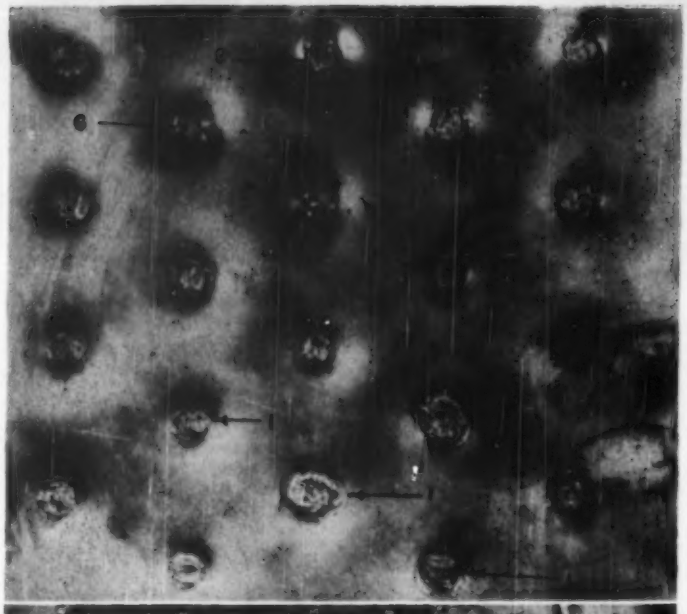


Figure 11. Plug Welded Liner.

Figure 12. Strip Welded Liner.

fabrication, and alloy welding. The only distinction that is made is between acetylene welders and metallic arc welders. Qualification tests for both of these types are identical except that the welds are performed by the method for which the welder is endeavoring to qualify.

Qualification tests are two fold, consisting of a butt welded plate test and a position pipe welding test. Figure 16 shows the details of the specimens making up these two tests.

On the plate test, two pieces of ASTM A-285 firebox grade carbon steel ½-inch thick are butt-welded together, all welding being performed from one side using AWS E-6010 electrodes. Figure 17 shows a welder performing the plate test. In this test, the two pieces are tacked together and the specimen fixed in a position about head high. The elevation of the specimen may be altered at the discretion of the inspector, sometimes being as low as 24 inches above the floor. In all cases, however, the weld is an overhead weld.

The position pipe welding test consists of welding up the closed specimen shown in Figure 16. AWS E-6010 electrodes are also used on this test. It is required that the specimen be mounted with the 4-inch run in a horizontal position with the 3-inch lateral pointed downward. The specimen is tacked together and then fixed in a location 24 inches from the floor and 8 inches from a wall and must remain so fixed until all of the welding has been performed. Figure 18 shows a welder actually performing a position pipe test.

During the qualification tests, the quality of the welding is carefully scrutinized by an inspector and the welder's ability to weld evaluated in general terms. The plate test is cut into four strips and physical tests conducted as shown in Figure 16, thereby evaluating the physical properties of the weld. The pipe specimen is hydrostatically pressure tested at 1600 psi. and must show no leaks. Samples are cut from the welds and are etched and closely examined. In some cases X-ray examination may be made. A point system has been devised on such factors as general appearance, root penetration, slag inclusion, blow holes, reinforcement, and physical properties. Using this system, each welder is graded. A welder must receive 80 out of a possible 100 points in order to satisfactorily qualify.

Welding operators employed by contractors are also required to pass qualification tests before they are permitted to weld on refinery equipment, but because of their special operations, contractor welders are permitted to qualify on either the plate test or position pipe test instead of being required to take both tests. In these cases, the welder may perform only the type of welds for which he took and passed qualification tests.

Where alloys are encountered, or where specified electrodes are different than those normally handled, or an unusual welding procedure is required, a welder may be required to qualify using the particular electrodes, materials, and welding procedures specified for the work in question.

All welders, both refinery and contractor, who satisfactorily pass the qualification tests are assigned an identification stencil, and all welds made by a welder must be clearly marked with his stencil.

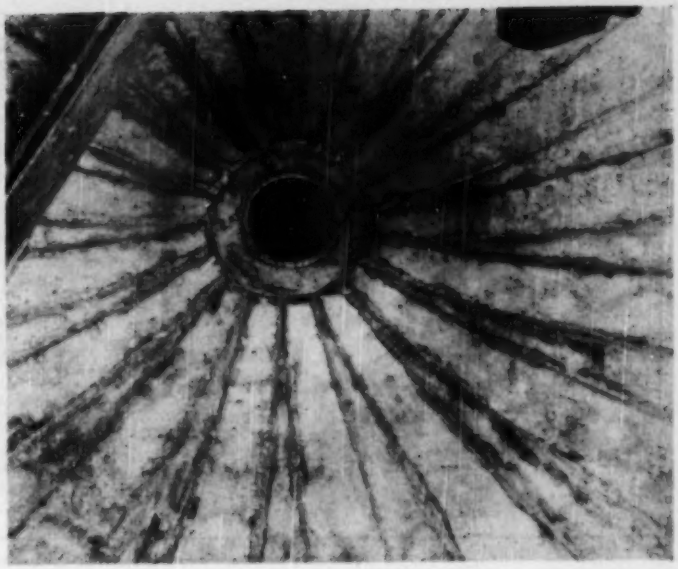


Figure 13. Field Installation of Inconel Liner.

Welding Inspection

The high quality of welding demanded in the refinery is assured through welding inspection. It has been found that one inspector can adequately cover the work performed by twenty to thirty welders when considering refinery welders. Somewhat closer inspection coverage has been found desirable for contractors' welders. The inspectors working among the welders observe the preparation of the joints for welding, the fit up, the performance of welds, and the completed welds. Where it is possible to observe a weld being performed through all of its stages up to completion, a decision is readily reached as to its suitability. Where this is not possible, representative welds are trepanned or plug samples are burned out. An endeavor is made to take at least one plug sample from each refinery welder every three months. In most cases, samples are cut at a much greater frequency than this, especially where welding is performed on pressure equipment. In general, the number of plug samples taken is based on the footage of welding performed, this often being prescribed by some construction code or job specification.

All plug samples are cleaned, etched, and carefully evaluated. Figure 19 shows an etched sample cut from

Figure 14. Hastelloy B Pump Liner.

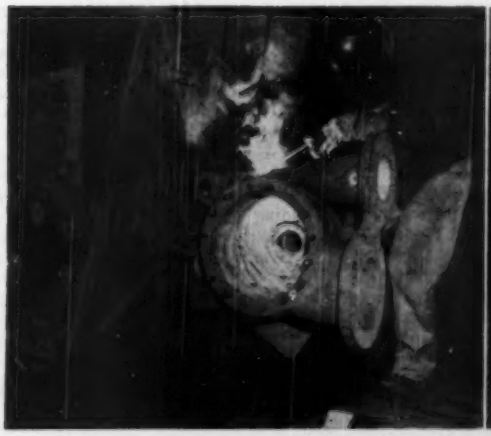
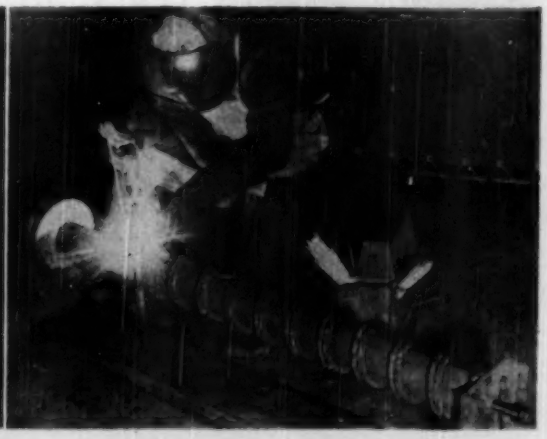


Figure 15. Hard Surfacing of Catalyst Screw.



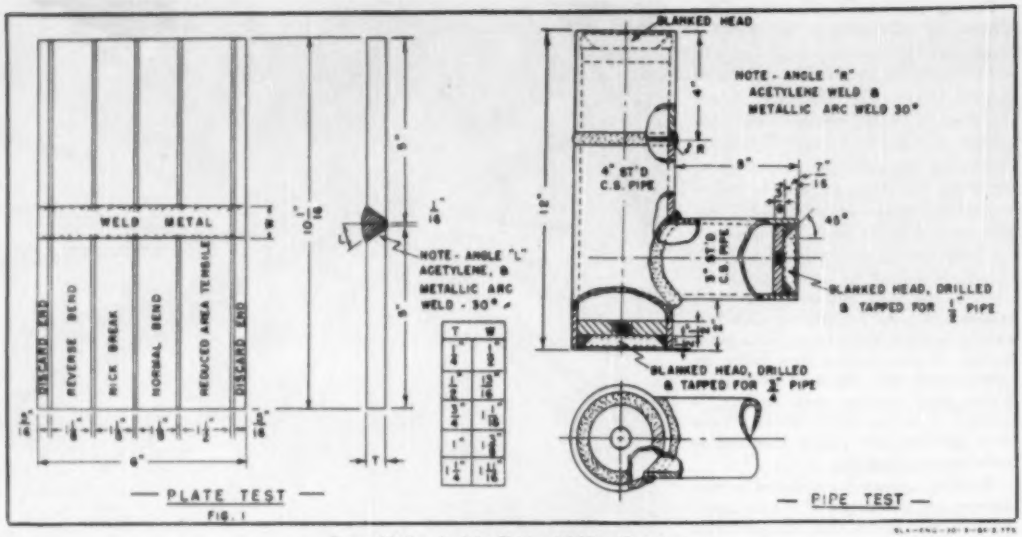

BLANKED HEAD
NOTE - ANGLE "R" ACETYLENE WELD & METALLIC ARC WELD 30°
4" STD C.S. PIPE
NOTE - ANGLE "L" ACETYLENE, & METALLIC ARC WELD - 30°
BLANKED HEAD, DRILLED & TAPPED FOR 1/8" PIPE
BLANKED HEAD, DRILLED & TAPPED FOR 3/4" PIPE
WELD METAL
DISCARD END
REVERSE BEND
NICK BREAK
NORMAL BEND
REDUCED AREA TENSILE
DISCARD END
— PLATE TEST —
— PIPE TEST —
FIG. 1

Figure 16. Standard for Testing Welding Operators.

a representative pipe weld and exemplifies the high quality of welding required. Particular attention is devoted to laying in a good root or stringer bead. It will be noted in this figure that the root bead is extremely sound and projects inside of the pipe wall approximately 1/8-inch. In order to obtain this quality in pipe welding, continued practice led to the development of a dragging technique for pipe welding. A 1/8-inch AWS E-6010 electrode is used with the welding machine set at normal amperage and voltage for the electrodes selected. The arc is struck and immediately the electrode is pressed deeply and firmly into the root of the joint and is dragged around the pipe. In placing this bead almost all of the arc will be inside of the pipe. In straight down hand work, the electrode is dragged slowly enough to allow depositing the weld metal as it progresses. In overhead and vertical welds, essentially the same technique is used, except a series of dragging movements approximately 1 inch long working uphill are resorted to. After depositing the root or stringer bead, 5/32 or 3/16-inch electrodes are used and the weld completed. The reinforcement should project about 1/16-inch above the pipe wall and should be well rounded from the edges to the middle.

Figure 17. Overhead Plate Test.

Where the sample reveals bad welding, it is brought to the attention of the welding foreman and the joint is cut out and rewelded. This matter is called to the attention of the welder who performed the weld, and in an instructive rather than critical manner, the defects are pointed out to him and he is advised how these may be overcome. When a welder performs a substandard weld and the matter has been brought to his attention, the work performed by this welder is closely followed until an improvement has been made in the quality of his work. This has resulted in a keen appreciation by the welders of the high quality demanded and it has become extremely rare that sub-standard welding samples are taken. It has been brought out that each welder has an identification stencil assigned to him and each weld performed by him must be prominently marked with his stencil. A welding record is maintained on each welder, both refinery and contractor, and all information pertaining to the qualification test and quality of welds obtained in welding samples is recorded thereon.

Welding Procedure

A good measure of welding quality control is obtained through the development and execution of proper welding procedures. The inspection group has experienced welders and metallurgists working in close cooperation, and often on abnormal jobs, special welding procedures are developed and job specifications outlining these procedures are issued. A carefully planned operation naturally produces more successful and better quality welding than hit or miss welding operations conducted during the performance of the actual job. In some cases, some experimentation may be conducted to determine a suitable welding procedure, while in other cases it may be a job where experienced welders and trained metallurgists are able through experience and knowledge to work out a procedure in advance which will facilitate the welding operation.

Heavy weldments such as illustrated in Figure 5 are an example of this type of welding quality control. In this installation, the vessel wall is 2 inches thick, the reinforcing ring 1½ inches thick. Prior to welding, the area surrounding the manhole was preheated with acetylene torches from 300° to 400°F. Two welders were used on the inside and two welders on the

outside. The four welders began welding simultaneously, the outside welders beginning diametrically opposite on the horizontal axis and the inside welders diametrically opposite on the vertical axis. By this means, all of the welders were welding at a different point. The weld was deposited in a cascade manner, that is, a short bead is run out, then the welder steps back and puts the second pass on the weld already deposited. He continues to step back on the deposited weld until the joint is completely filled. Using successive operations of this type, he progresses around the welded joint. The thickness involved was such that the API-ASME Code required stress relieving. After all welding was completed, a gas burner ring was used to raise the metal temperature in the area of the attachment, and thermal stress relief was carried out in accordance with the code requirements. The burner ring permitted heating to about 1050°F. Jobs of this type are usually covered by welding procedures or job specifications.

The installation of 18-8 chrome nickel and monel vessel liners is frequently done in the refinery. Although this has become a common practice, it has been found that the jobs are facilitated by preparing and issuing welding procedures or job specifications on each of the liner installations. These specifications establish whether the liner is to be plug welded or strip welded and specify the spacing and size of plug holes or the width of the lining strips. The type and size electrodes desired are also specified.

The use of air hardening steels such as the straight chrome alloys, 5 percent, 9 percent, and 13 percent chrome; low nickel steels in cold services where impact at sub zero temperatures is important; monel, where iron pick up may seriously reduce corrosion resistance; and austentic steels, such as 18-8 chrome nickel type 304, where intergranular corrosion may be a factor, are other examples where it has been necessary to develop welding practices and prepare job specifications.

Figure 18. Position Pipe Test.

Evaluation of Welding Electrodes

Welding quality control is also exercised through the evaluation of welding electrodes. Periodically, electrodes in the AWS classifications normally used in the refinery are obtained from a large number of the manufacturers of welding electrodes. These electrodes are tested comparatively from the standpoint of general weldability, acceptability by the welders, chemical and physical properties of the deposited weld metal, amount of slag deposition and ease of its removal, and durability of the coatings both during welding and in storage. From these tests, a group of suppliers is determined who can furnish electrodes in each classification that satisfactorily meet the requirements, and purchases of the electrodes are limited to the suppliers of the approved rods. Between the periods of these large scale tests, individual tests are frequently conducted to evaluate electrodes not previously tested. Figure 20 shows the filling of a 2-inch angle with deposited weld metal. From this deposited weld metal a .505-inch diameter tensile specimen will be machined and physical properties obtained. A chemical analysis of the deposited metal will also be made. During the preparation of this sample and other test pieces, the other criteria listed above are evaluated.

Welding Research

Under welding quality control, welding research undoubtedly contributes a good measure. It is the responsibility of the inspection group through the cooperation of the experienced welders and metallurgists in this group to keep abreast of and investigate developments in the field of welding.

In this work perhaps notable achievement has been made in the refinery in the field of cast iron welding. Various cast iron welding techniques have been experimented with and several methods have been developed by which cast iron can be successfully welded by the metallic arc process. Figure 21

Figure 19. Pipe Weld Sample.

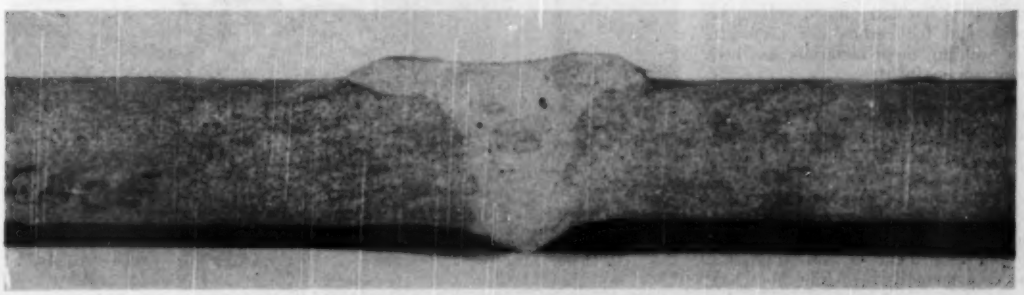


Figure 20. Specimen for Electrode Evaluation.

illustrates the repair of a cast iron compressor cylinder. A preheat furnace can be seen and the welders are noted on top of the furnace actually performing the welding. In this job, the cylinder was uniformly preheated to about 600°F. and a cast iron a.c. electrode was used. Successful techniques have also been developed for the use of the high nickel electrodes commonly used for electric arc welding of cast iron materials. The welding of cast iron is very complex and often the welding procedures must be altered to meet the conditions. Therefore, with this type of work, several methods have been developed, some requiring preheat and others requiring no preheat, which have proved successful. Through careful study of the particular job, it is possible to select a suitable welding procedure and perform electric welding on cast iron successfully.

In the handling of chemicals in the refinery, a large amount of copper or copper alloy is used. Corrosion in this equipment has necessitated welding repairs and the carbon arc procedure for welding these materials has been used successfully.

Developments such as submerged arc welding, shielded inert gas arc welding, powder cutting, oxy-arc cutting, stud welding and a.c. welding are investigated and their adaptability to refinery uses evaluated. Perhaps the most notable achievement in this field was the decision to use a.c. welding in the performance of certain types of welds principally involving shop work. Until this time, only d.c. welding machines had been used. While both a.c. and d.c. welding enjoy certain advantages and disadvantages, it has been found desirable to use both types of welding.

Conclusions

In conclusion, it should be brought out that welding is so closely related to welding quality control that it is difficult to segregate the two into distinct items. The subject has been presented principally from the standpoint of welding quality control, but the things which have been achieved were brought about through the close cooperation of the welding department which supervises the welding operations and the equipment inspection department which supervises the welding quality control. Through the efforts of these two groups, an extremely high quality of welding is realized and welding is accomplished in a most efficient manner.

Reiterating, the principal points of welding quality control are:

1) Selection of proper personnel through welders qualification tests.

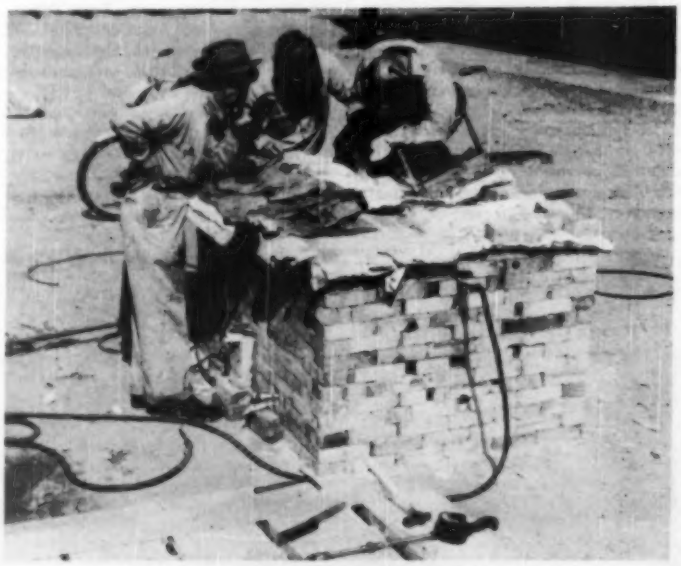
2) Follow-up in welding operations through welding inspection, consisting of observation of jobs in progress, sampling and evaluation of finished welds, constructive instructions to welders who perform sub-standard welding, and maintenance of welding records.

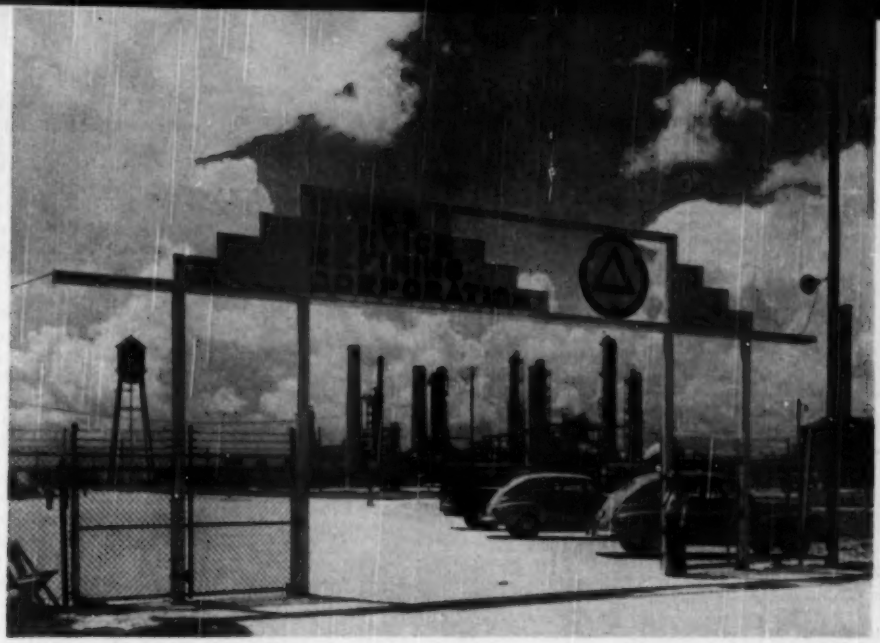
3) The development and use of suitable welding procedures, and facilitating welding operations through the preparation of job specifications.

4) The testing and evaluation of welding electrodes to compare their relative merits and to classify suppliers of acceptable electrodes.

5) Conducting welding research so that welding procedures may be tested and evaluated, and investigating the latest developments in the field of welding so that their adaptability to refinery uses may be determined.

Figure 21. Welding Cast Iron Cylinder.





Entrance to Cities Service Refining Corporation's Plant, Lake Charles, La.

For Management—

How to Interpret Earnings Changes In an Oil Company

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Over-all changes in sales and cost of sales tend to be inscrutable composites in lines in which the picture is impracticable of completion by carrying analysis of performance against budget or of variance from standard costs (where either of these devices is used) through to final profit and loss. This discussion offers a practical procedure for accounting for the differences between sales and cost of sales from one period to another in terms of principal causes. In the case of changes in sales, the breakdown is limited to the factors of price and volume. Analysis of changes in cost of sales is detailed to numerous contributing influences. This article originally appeared in the July, 1950, issue of the N.A.C.A. Bulletin published by the National Association of Cost Accountants.

THOSE of us who have the responsibility of preparing earnings statements for top executives know from experience that the first thing they do is to look at the bottom line which shows net earnings. If the result which appears there is equal to or better than anticipated, everybody is happy. Incidentally (and perhaps not deservedly), the accountant rises in favor. If, on the other hand, net earnings should fall short of expectations, every responsible executive from the top on down will want to know what caused the decline, and rightly so. Should the accountant be unable to give a satisfactory explanation, he is by no means as favorably regarded. While this may in general portray typical reactions toward earnings changes, it may be added here that the accountant is equally at fault if he does not know the causes of earnings increases as well as of decreases.

Since this is a case study, a little background is in order. The company in question purchases its crude oil and some of its blending stocks. Not all the crude run in any one month is fully processed into finished products in the same month. Some of it is carried over into the next month as materials in process (distillates). Likewise, not all the finished products produced in any one month are sold within the same month, some of them being carried forward in inventories. Manufacturing costs, i.e., cost of crude run plus manufacturing expenses are apportioned to products under what is known as the market price method which has been defined as "a method whereby common costs are allocated to the several commodities in proportion to the relative market value of the products obtained." Crude run is costed at an annual basis price on what is commonly referred to as the "lifo" method of costing. Refined oils are carried in stock under what is known as the average price method, i.e., sales are costed at weighted average cost of opening inventory plus acquisitions, and subsequently adjusted to the "lifo" method for earnings statement purposes.

No Easy Matter

To the uninitiated it may appear that it should be a simple matter to determine the reasons for earnings variations. However, nothing could be further from the truth. It is virtually impossible to give an intelligent explanation of earnings changes in a set up such as is outlined above, merely

TABLE 1

Commodity	Separation of Change in Sales Between Amount Due to Price and Amount Due to Volume									
	JUNE, 1949			July Sales at June Prices	JULY, 1949				Increase Due to Volume	(Decrease) Due to Price
	Quantity	Price	Amount		Quantity	Price	Amount	Total		
Gasoline	10,000	.15	$1,500	$1,800	12,000	.20	$2,400	$600	$300	$600
Kerosine	12,000	.12	1,440	960	8,000	.10	800	(640)	(480)	(160)
Furnace Oil	15,000	.07	1,050	840	12,000	.09	1,080	30	(210)	240
	37,000	.....	$3,990	.....	32,000	.....	$4,280	$290	(390)	$680

Similar comparison schedules prepared for categories of cost.

TABLE 2

Significant Factors in Analysis of Changes in Cost of Sales

Factors which Influence Unit Cost Prices in Yield From Crude Run	Sources of Refined Oils		Disposition of Refined Oils	
	Opening inventory		Closing inventory	
	Purchased oils			
	Materials in process (distillates)			
	Blended material			
(1) Changes in crude price		Total to account for (stock ledger figure)		
(2) Changes in crude throughput				
(3) Changes in manufacturing expense			Cost of sales (average price method)	Cost of sales
(4) Changes in liquid recovery	Yield from crude run			
(5) Changes in credit for gas and oil used by company			Cost of sales "lifo" adjustment	
(6) Changes in type of products manufactured				

by comparing the various items in the conventional form of earnings statement for one period with that of another. The reason, of course, is that there are earnings statement items—particularly sales and cost of sales—which reflect the influence of a number of different factors.

In order to determine the earnings effect of these various factors, we have developed methods of analysis which will be outlined here. The purpose of the analysis is roughly to account for earnings changes resulting from changes in sales and cost of sales, by factors or influences responsible. It should be stated at the outset that no claim is made for absolute accuracy. Items are shown in thousands of dollars and no attempt is made to account for all of the differences in cost of sales. However, this should not detract materially from the result if the unaccounted for difference does not exceed, say, 5 percent of the total and if the figures are used only for the purpose intended.

Changes in Sales: Price and Physical Volume

Changes in total value of sales may result from changes in volume and type of products sold or to changes in prices. Consequently the difference in sales value from period to period on individual commodities is broken down as due to changes in volume and due to change in price, through the use of what for want of a better name we shall call a volume-price formula. It is along the lines of this formula that Table 1 is constructed. The separation there displayed is arrived at as follows:

Extend current period sales quantities by prior period sales prices and compare the result of this extension with aggregate sales for both the prior and current periods. The difference between the computed amount and the prior period sales is the amount due to change in volume. The difference between the computed amount and current period is the amount due to change in price. It should be noted that, related to sales totals, the amount arrived at as due to change in volume is in fact a composite representing the portion of the change in dollar sales which is due to change in volume and change in type of products sold.

It will be seen from the next section of this paper that the foregoing formula is made use of also in tracking down the causes of changes in cost of sales.

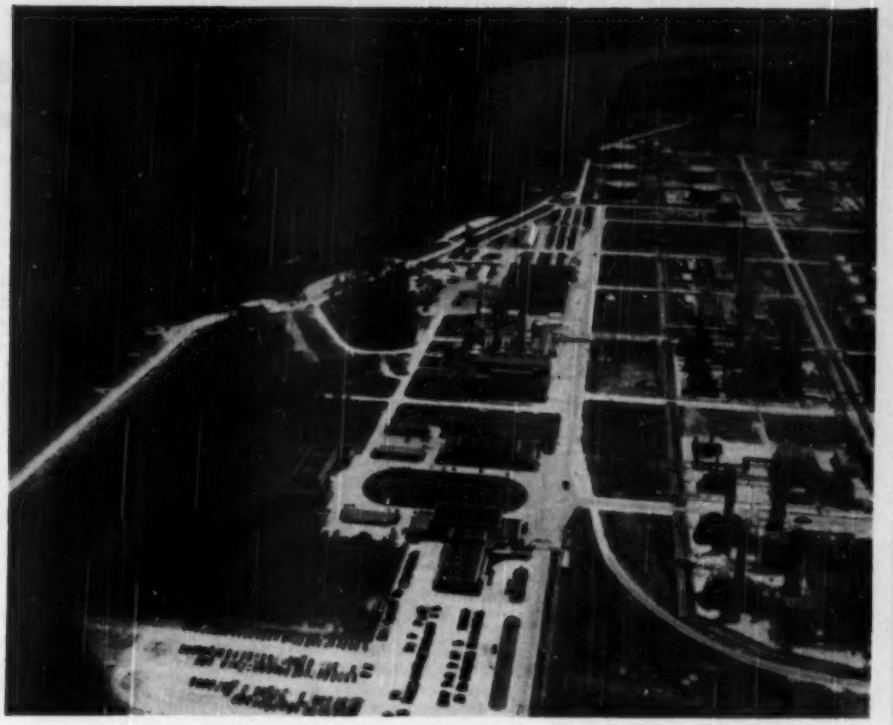
Changes in Cost of Sales Application of Procedure

To make an intelligent analysis of cost of sales, it is well to have before us a clear picture of how cost of sales is arrived at, as well as an enumeration of the factors which influence the variations in unit cost prices. To this end a chart has been prepared which is shown as Table 2. The starting point in an analysis of cost of sales changes is the stock ledger figure arrived at by adding acquisitions from all sources to the opening inventory. This aggregate figure we shall call "total to account for."

On the theory that if all factors entering into the current period operation were the same as for the prior period there should be no change in unit cost prices of refined oils, the difference shown as due to price as determined by the application of the volume-price formula to the totals to account for of successive periods is the amount which must be analyzed both as to source and disposition.

Closing inventory and over-all cost of sales should be also analyzed by the application of the volume-price formula to the figures for the periods being compared, the latter after eliminating the "lifo" adjustment. Two separate schedules may be used for this. Obviously, since the unit cost prices for the various commodities are identical for all three schedules, the sum of the break-down items of closing inventory and cost of sales either as to "due to volume" or "due to price" should equal the like separation on "total to account for." Having thus established and controlled the total amount representing change in unit cost prices and, moreover, having determined—by application of our formula to cost of sales and closing inventories—the portion thereof which went into cost of sales and the amount which was retained in closing inventory, the next step is to trace back the source of the changes in unit cost prices following the outline of change causes presented in Table 2.

In case of continuous monthly earnings analysis, no breakdown would be necessary for the difference between opening inventories for the reason that last month's closing inventory becomes this month's opening inventory and hence the breakdown of the difference between last month's closing inventories can be carried forward. In the cases of purchased oils or of additions to stock resulting from the completion of materials in process or from blending several materials, unit cost price changes would be involved. For example if a product priced at 8 cents per gallon is combined with a product carried on the books at 10 cents per gallon, the average book cost price of the recipient product will be influenced downward by an amount equal to 2 cents multiplied by the number of gallons so added. In view of the simi-



Airview of Cities Service Refining Corporation's plant, Lake Charles, La.

larity of the method of calculating the price effect of acquisitions of the above three types, they may be combined and the price effect determined on the composite figure.

However, for the purpose of determining effect of change in price structure to be explained later, it is desirable in addition to break down the difference in purchases as between amounts due to volume and due to price. Next the difference in yield from crude for the periods under consideration is analyzed by the application of the volume-price formula.

Tracing Changes in Costs to Specific Causes

Having thus analyzed all the items entering into "total to account for," it now remains to reconcile the changes determined as due to price in respect of the three cost factors with amount due to price on total to account for. This cannot be done exactly, for the reason that, unless either the quantities or the prices for the periods compared are the same for all like items, the application of the volume-price formula to the total will not produce a breakdown equal to the sum of breakdown amounts of the individual items.

There are several viewpoints which may be taken as to disposition of the difference. One is to regard it as another factor which may either be separately stated or included in an unaccounted for item. Since, in actual practice, it is relatively small and also because it would be very difficult to explain, it should be included as an unaccounted for item if it is regarded a change factor. The other viewpoint is that the amounts of change due to price as calculated on the individual items are the correct amount of the price effect, and that the change due to price as determined for "total to account for" merely governs the rate at which it is absorbed in cost of sales. Under this interpretation both the "total to account for" and the closing inventory are adjusted for the discrepancy. Over a period of time this will fluctuate back and forth and will tend to equalize. It may, however, temporarily reflect cost changes suspended in inventories which appear to be out of alignment with actual developments.

Analyzing yield from crude as to the factors which influence the unit cost prices is perhaps the most important move in the procedure and is accomplished by determining, through the best method available, the amount by which each factor influences such prices. In our case, these factors and their influence are as follows:

1) *Change in crude price*—Since crude stocks are carried on a single group "lifo" basis, the volume-price formula is applied only to the total of all crude run for the respective periods.

2) *Changes in crude thruput*—The cost per barrel of thruput for the respective periods is determined by dividing the manufacturing expense of the prior period by the barrels of thruput for each period. The current month's thruput, extended by the difference in thruput cost, represents the amount by which unit cost prices were influenced by change in thruput.

3) *Changes in manufacturing expenses*—Total change is analyzed by classified accounts.

[Note: With reference to (2) and (3) above, there is, of course, another method of considering changes in these items. For example, the position could be taken that there is no change in manufacturing expense unless the expense per barrel run in the respective periods changed. One disadvantage of this method is that the change in manufacturing expense could not be identified by classified accounts and another is that indirect expenses do

TABLE 3

Detailed Statement of Causes of Changes in Earnings

(Figures in thousands of dollars; negative effects on profits appear in parentheses)

Net earnings—current period			$ xxx
Net earnings—previous period			xxx
Increase to account for			$ xx
Accounted for by:			
1. Increased gross sales resulting from change in sales volume and type of products sold		$ xxx	
2. Increased gross sales resulting from increased sales prices		xxx	
3. Increased sales allowance		(xx)	
4. Decreased other operating gross		(x)	
5. Increased cost of sales resulting from change in sales volume and type of products sold		(xxx)	
6. Decreased cost of sales due to decreased unit prices resulting from:			
(a) Effect of difference in opening inventories on unit price	$ (x)		
(b) Effect of differences in purchased oils, processing of distillates and blending operations	xx		
(c) Effect of yield from crude run.			
(1) Decreased cost of crude run due to decreased price	$ xx		
(2) Effect of increased crude thruput	xx		
(3) Decreased manufacturing expenses	xxx		
(4) Increased liquid recovery	xx		
(5) Decreased credit for gas and oil used by company	(x)		
(6) Effect of differences in type of products manufactured from crude run	(xxx)		
Total price effect of changes in yield from crude run	xx		
(d) Unaccounted for	$ (xx)		
Total decrease in unit cost prices	xx		
Less amount in closing inventory	xx		
Balance to cost of sales		xx	
7. Increased selling, general and administrative expense		(x)	
8. Decreased nonoperating income		(x)	
9. Decreased interest and other charges		x	
10. Increased "lifo" inventory adjustment		(xxx)	
11. Increased income taxes		(xx)	
Total as above			$ xx

not fluctuate in the same proportion as does the volume.]

4) *Changes in liquid recovery*—The unit price effect of changes in liquid recovery is determined by applying the difference in percentage rate of recovery for the respective periods to the total manufacturing cost (cost of crude plus manufacturing expenses) of the current period.

5) *Changes in credit for oil and gas used by company*—The value of these products is charged to manufacturing expenses. Hence any changes in the offsetting credit must be taken into account.

6) *Changes in type of products manufactured*—The unit price effect of these changes is determined by removing current period yield from crude from current period "total to account for" and substituting therefor a calculated yield from crude based upon prior period percentage yields. The application of the volume-price formula to a comparison of the two results will determine the unit price effect of these changes. It should be noted, however, that this method will include with the result, the difference due to change in percent of liquid recovery and since this has been accounted for separately under (4) above, it should be eliminated from the result obtained.

The algebraic sum of the unit price effects of all of the above factors should approximately equal the difference due to price as determined for yield from crude. Any difference may be shown as a separate unaccounted for item.

Summary Reports of Earnings Changes by Causes

Having thus broken down changes in sales and cost of sales for the respective periods, into their elements, the difference in net earnings for the two periods may be stated somewhat as shown in Table 3. This statement, while excellent for use of the accountant and operating executives who are very familiar with the conditions, is too detailed for presentation to top flight executives. For such purposes the statement can be condensed by reassembling the various elements as to major cause. Such a condensation is shown in Table 4. Examples of possible item combination are as follows:

1) Items 1 and 5 both deal with change due to volume and type of products sold. The two may be combined and the net result shown as the increase or decrease in earnings due to change in volume and type of products sold.

TABLE 4

Condensed Statement Accounting for Earnings Changes

(Figures in thousands of dollars; negative effects on profits shown in parentheses)

Net earnings—current period		$ xxx
Net earnings—previous period		xxx
Increase to account for		$ xx
Accounted for by:		
1. Change in volume and type of products sold	$ xx	
2. Change in price structure	xxx	
3. Change in results from manufacturing operations	xx	
4. Change in amount of increased or decreased unit costs suspended in inventories	xx	
5. Change in "lifo" inventory adjustment	(xxx)	
6. Miscellaneous changes (net)	(xx)	
Total as above		$ xx

2) Items 2, part of 6b and 6c-1 all deal with changes in purchase or sales prices and these may, therefore, be combined and the net effect shown under the heading of change in price structure. If desired, item 3 may also be included under this heading. (With reference to item 6b, the part involved in this connection is the difference due to change in price of the purchased oils which should be determined as a separate operation through the use of the volume-price formula.)

3) The balance of item 6b after elimination of the amount due to change in price of the purchased oils, items 6c-2, 6c-3, 6c-4, 6c-5, 6c-6 and 6d may be combined and the net effect considered as the change in unit costs resulting from change in results from manufacturing operations.

4) Item 6a and the amount in closing inventory may be combined and the net result considered as the difference in the amount of increased or decreased unit costs suspended in opening and closing inventories.

An Open Door to Useful Comparisons

One advantage of this procedure for comparing earnings for different periods is that it makes possible a comparison, not only of succeeding months, but also of one month with the same month the previous year or for that matter, with any prior month. The procedure works best in a line of business where there are not too many products manufactured and where there is a fair degree of consistency in the products manufactured from month to month. Open end items, i.e., items represented in the current period but not in the prior period, present a problem. It is known that they contain a part of the overall change in costs but to determine what amount involves arbitrary decisions which are likely to contain an element of error. One method of resolving this difficulty is to assume that the price change was the same, percentage-wise, as that of the product most nearly resembling it or containing most nearly the same basic ingredients.

It may be noted that it is essential, if the procedure outlined is to be applied workably, for separate stock accounts to be kept for each product. Grouping stocks by classes and carrying stock accounts for the groups only would destroy the effectiveness of the volume-price formula on which the change analysis procedure in large part depends.

Planning Refinery Heat Transfer Equipment

Part III: Economical Proportions

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FIRST, operating, and maintenance costs all affect exchanger selection. Where fluids at high temperatures are handled, some means must be used to absorb expansion. "U" shaped tubes are satisfactory for high temperatures, as are floating heads. The "U" arrangement is often cheaper than a floating head but maintenance costs may be higher because mechanical cleaning of "U" tubes is difficult. Floating heads permit removal of the tube bundle for cleaning but the use of several floating heads usually increases heater cost by 1/3 to ½ over that of a single floating head exchanger.

The nature of the fluid pumped, its temperature, viscosity, and allowable pressure drop, determine, to a certain extent, how flow through the exchanger should be routed. Fluids which foul readily should be passed through the tubes because tube cleaning can be conducted without dismantling the exchanger. Passing a corrosive fluid through the tubes will lower exchanger initial costs by requiring corrosion-resistant materials in the tubes only. To avoid costly shells, the high-pressure fluid is usually passed through the tubes. Highly viscous fluids can be used to improve the over-all coefficient of heat transfer of the exchanger if they are made to flow through the shell instead of the tubes.

THE FIRST TWO parts of this article discussed heat transfer calculations applicable to refinery, natural gasoline, and petrochemical plant heat exchangers. It was shown that it is often possible for refiners to make preliminary design calculations which will help save time in plant layout. The calculations are not intended to replace those of the heater manufacturer. They are simply a substitute for his until they have been checked by him. This, the final article in the series, discusses economic equations and calculations.

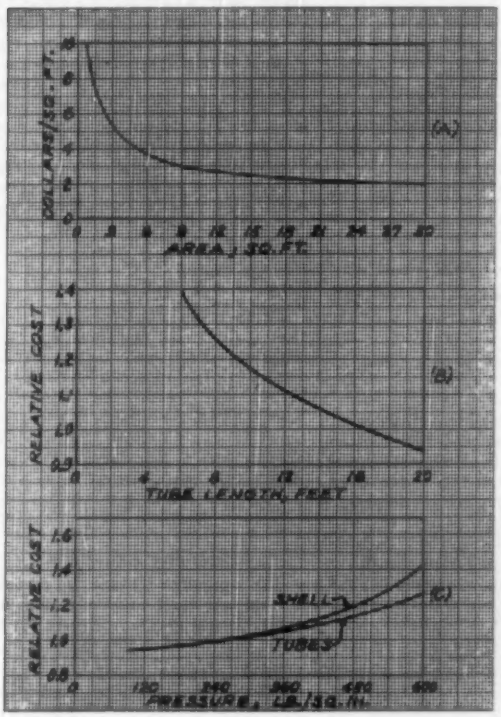


Figure 1. Typical cost relations for a steel shell - and - tube exchanger. Values given are approximate but they indicate the general variation to be expected when area, tube length, or pressure is changed.

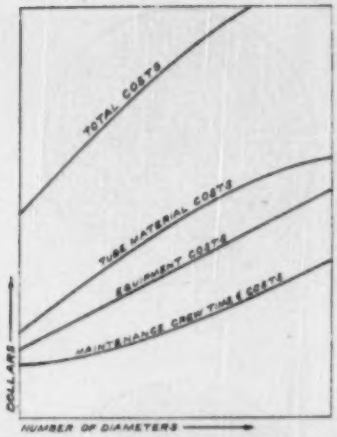


Figure 2. Typical refinery tube replacement costs showing the effect of increasing the number of diameters used in exchangers throughout the plant. The advantages of standardizing diameters is clearly shown.

Figure 1 shows graphically typical relations between various costs and exchanger area, working pressure, and tube length. As can be seen, the initial cost per square foot decreases with increased area. The area costs given are for a steel shell and steel tubes; other materials will change unit costs somewhat.

Tubes

Selection of a suitable tube length for refinery exchangers is usually determined by the allowable installation space and location with respect to the ground. Exchangers located on platforms high above the ground should, in general, have short tubes to facilitate maintenance. Longer tubes can be used in heaters mounted near the ground if there is sufficient space for removal of the bundle. Initial costs of long tubes are less than for short ones, as shown in Figure 1B. Savings in initial costs resulting from the use of long tubes can be offset by increased maintenance costs if the exchanger is located on a narrow plat-

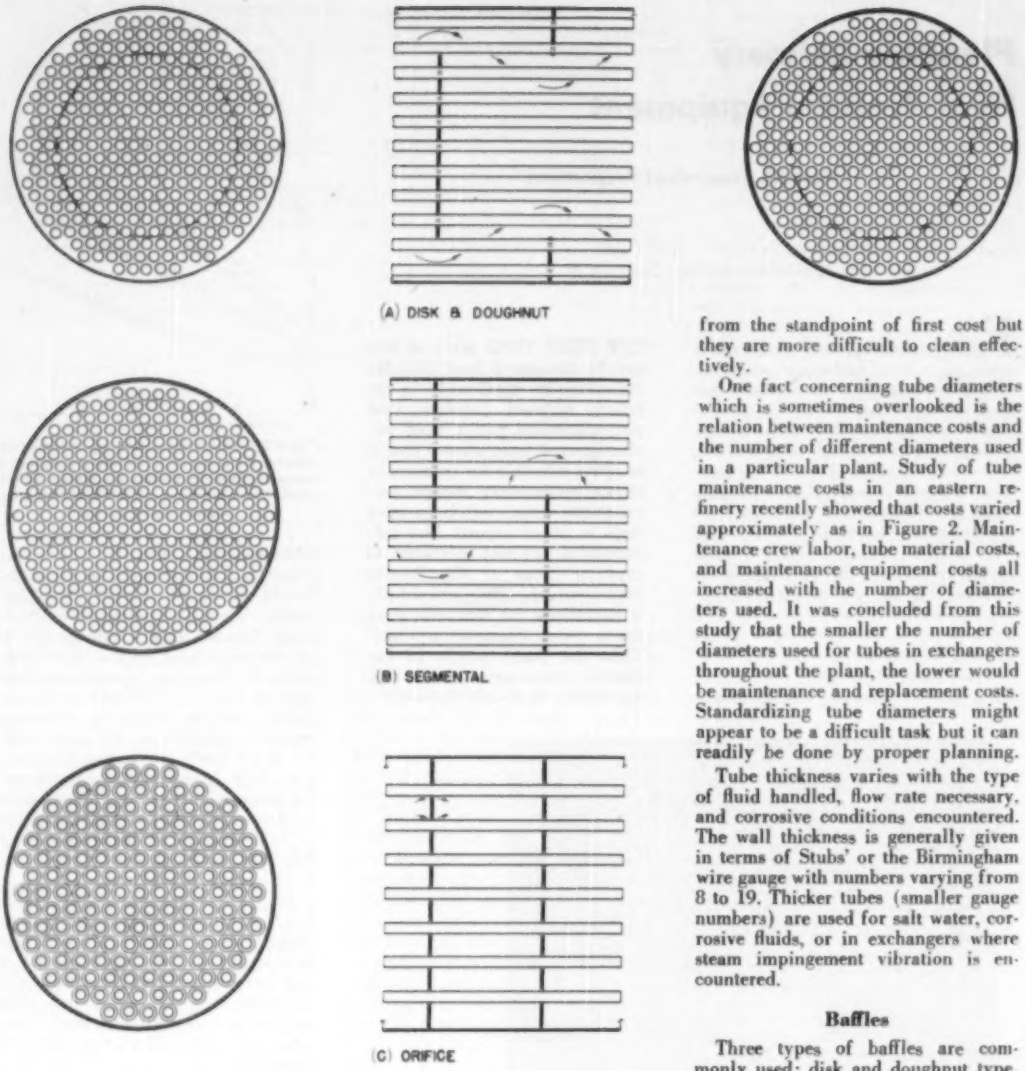


Figure 3. Baffling arrangements used in process exchangers

form or in a restricted space. Hence, it is a good policy to review existing maintenance procedures before using lower cost long tubes in places where working room is limited.

Admiralty alloy tubes are most common for condensers and exchangers in crude and re-run stills, cracking and polymerization plants, and in some petro-chemical units. These tubes are usually suitable for sweet or sour overhead gas streams and crude and re-run still feeds. Red brass (85 percent) has good resistance to the oxidizing effects of spray tower water and is seldom affected by entrained air. Besides, it is more slowly attacked by sulfuric-acid oil mixtures than other tube materials. As a result it is a widely used material for exchangers in refineries. Many petro-chemical plants are now using copper-nickel alloys because highly corrosive conditions prevail.

The most common outside diameters in use range from $\frac{5}{8}$ to $1\frac{1}{2}$ inches. Fluids which foul excessively generally require use of the larger diameters to prevent rapid plugging and excessive shutdowns for maintenance. Small diameter tubes are desirable from the standpoint of first cost but they are more difficult to clean effectively.

One fact concerning tube diameters which is sometimes overlooked is the relation between maintenance costs and the number of different diameters used in a particular plant. Study of tube maintenance costs in an eastern refinery recently showed that costs varied approximately as in Figure 2. Maintenance crew labor, tube material costs, and maintenance equipment costs all increased with the number of diameters used. It was concluded from this study that the smaller the number of diameters used for tubes in exchangers throughout the plant, the lower would be maintenance and replacement costs. Standardizing tube diameters might appear to be a difficult task but it can readily be done by proper planning.

Tube thickness varies with the type of fluid handled, flow rate necessary, and corrosive conditions encountered. The wall thickness is generally given in terms of Stubs' or the Birmingham wire gauge with numbers varying from 8 to 19. Thicker tubes (smaller gauge numbers) are used for salt water, corrosive fluids, or in exchangers where steam impingement vibration is encountered.

Baffles

Three types of baffles are commonly used: disk and doughnut type, segmental type, and orifice baffles, Figure 3. The closer the spacing of baffles, the greater the number of velocity changes which will be obtained during fluid flow. Since baffles are subjected to many accidental blows during tube maintenance, they should be amply braced with tie-rods and spacers to prevent damage or shifting.

Economy Equations

The optimum velocity in refinery, natural gasoline, and petro-chemical exchangers is that which gives the desired heat transfer with the minimum pumping costs. With the fluid flowing inside the tubes, the cost of pumping power for the tubes alone is

$$C_t = \frac{P_t A_t}{q} \quad (1)$$

where

C_t = tube pumping cost, dollars per Btu. transferred,
P_t = hourly cost of tube pumping power, dollars per square foot of heat transfer surface
A_t = total internal area of the heat transfer surface, square feet
q = heat transferred, Btu. per hour.

The cost of shell pumping power is,

$$C_s = \frac{P_s A_t}{q} \quad (2)$$

where the symbols C_s and P_s are the same as above except that they refer to flow outside the tubes.

The fixed charge on an exchanger used for process work is

$$C_f = \frac{H_t A_t}{q} \quad (3)$$

where

C_f = fixed charge, dollars per Btu. transferred
H_t = fixed charges, dollars per hour per square foot of internal heat transfer surface, and the other symbols as before.

The pumping cost for lifting water from the source and discharging it at the exchanger level is, for the piping,

$$C_p = \frac{P_t A_t}{q} \quad (4)$$

where

C_p = pipe pumping cost, dollars per Btu. transferred
P_t = hourly cost of pipe pumping power, dollars per square foot of heat transfer surface, and other symbols as before.

Total cost of exchanger operation is therefore

$$C_t = C_t + C_s + C_f + C_p \quad (5)$$

At present there are two methods for determining the total cost, C_t:

1) The simplest method, uses assumed velocity values for determination of the pressure loss in the exchanger tubes. For each assumed velocity value the corresponding pressure loss is then used for finding the tube pumping power required. Shell pumping power, exchanger fixed charges, and pipe pumping cost are likewise determined. By comparing the total operating cost at various velocities, the optimum velocity, that which gives the lowest operating cost, is found. As can be seen, this is an indirect solution and requires knowledge of typical velocity ranges before it can be applied.

2) The method, widely used by exchanger manufacturers, solves directly for the optimum velocity by means of specially derived equations. These equations are based on the cost relations given above and on special relations correlating exchanger and fluid characteristics. In general, these special relations are too involved for the preliminary computations which refinery designers usually make.

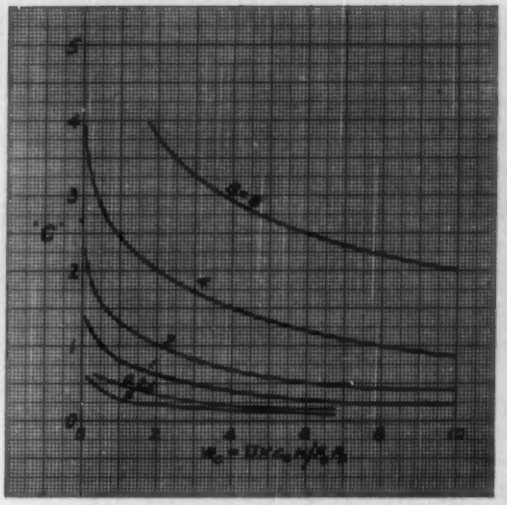


Figure 4. Constants for use in equation 6. An illustrative example showing the application of these constants is given in the text.

Cooling Water Flow

As in other phases of process exchanger relations, there is an optimum quantity of cooling water for exchanger operation. If the annual sum of fixed charges on the exchanger and cost of water is W_c, then

$$W_c = \frac{UKC_c H}{F_c F_t} \quad (6)$$

where

K = a constant = 1.0 for counterflow apparatus
C_c = water cost, dollars per pound,
H = number of hours exchanger is operated annually
F_c = first cost of exchanger, dollars per square foot
F_t = fractional portion of fixed charges paid off annually.

The optimum quantity of water is that which provides the desired cooling with the minimum flow rate. Solution of equation 6 is facilitated by Figure 4.

Example 1:

A refinery counterflow exchanger is to cool 8000 pounds per hour of an oil having a specific heat of 0.60 from 250° F. to 100° F. Water entering at 75° F. and costing $0.30 per 50,000 pounds is to be used for cooling. If the annual charges on the exchanger are $0.75 per square foot, U = 9, and the exchanger operates 8000 hours per year, determine the area required and the optimum outlet temperature for cooling water.

Solution: From equation 6,

$$W_c = \frac{UKC_c H}{F_c F_t} = \frac{9(1.0)\ (0.30/50{,}000)\ (8000)}{0.75\ (1.0)}$$

$$W_c = 0.576$$

$$B = \frac{t_A - t_B}{t_B - t_1} = \frac{250 - 100}{100 - 75}$$

$$B = 6$$

From Figure 5,

$C = 4.2$ when $W_c = 0.576$ and $B = 6$.

Then,

$$C = \frac{t_A - t_2}{t_B - t_1},$$

$$\text{or } 4.2 = \frac{250 - t_2}{100 - 75}$$

$$t_2 = 145° \text{ F}$$

This is the optimum outlet temperature for operation at the given conditions.

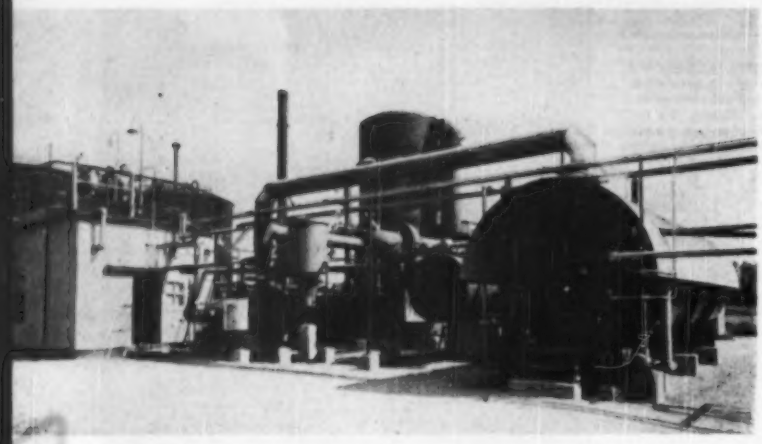
Required area is

$$A = q/Ut_m = (8000)\ (0.60)\ (250 - 100)/(9)\ (20.9)$$

$$A = 3840 \text{ square feet}$$

Conclusions

Refinery, natural gasoline, and petrochemical plant designers can often save time during layout by making preliminary heat transfer calculations. Over-all dimensions of the exchanger can be approximated by means of these calculations. Final exchanger dimensions must be fixed by the manufacturer but the preliminary values will not differ materially from final ones if standardized exchangers are selected.



Equipment Eliminated in New Sulfuric Acid Process

A NEW way to make sulfuric acid which eliminates seven major items of equipment, used in the conventional contact process, has been developed by Chemical Construction Corporation of New York.

The new design represents an estimated saving of as much as 20 percent of the present capital cost of an erected medium size sulfuric acid plant in the United States, company officials say. A commercial-size plant embodying this new design has been in operation since early June of this year at American Cyanamid's works at Hamilton, Ohio.

The new process is the result of the development of the quench converter, bubble absorbers using evaporative cooling, and low cost Pease-Anthony venturi sulfuric acid mist eliminator.

Traditional components of conventional contact installations which are no longer needed include the drying tower, gas filter, heat exchanger between primary and secondary converter, sulfur trioxide cooler, acid coolers, acid transfer pumps and piping, and dilution system consisting of dilution tank, pumps and cooler sections.

Elimination of the drying tower made it necessary to omit all heat exchange surfaces as potential corrosion hazards. The quench-type converter was developed to solve the problem of interstage cooling.

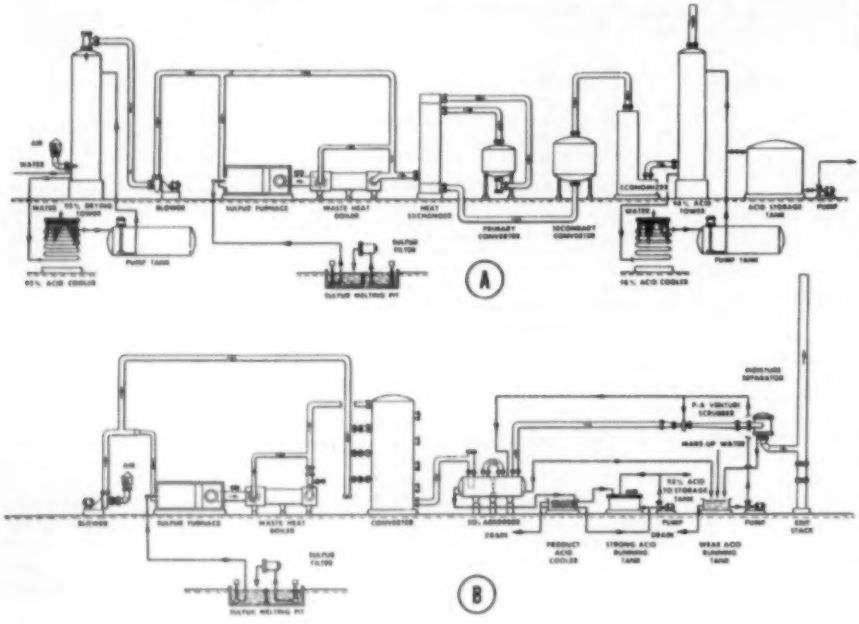
Catalytic oxidation of sulfur dioxide is carried out in four successive stages. Temperature control is effected by admitting cold, atmospheric air between the converter stages.

With burner gas containing 12 percent sulfur dioxide by volume and using a catalyst loading equivalent to that of conventional contact converters, conversion of SO_2 to SO_3 in excess of 99 percent is consistently achieved.

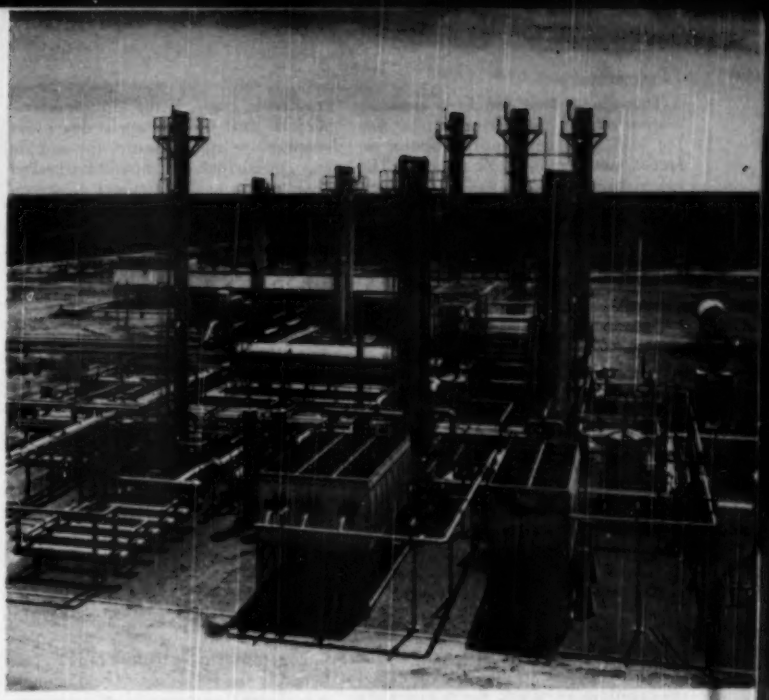
The entire heat load provided by the sensible heat of the gases leaving the converters as well as the heat of formation of the sulfuric acid is removed by latent heat of evaporation of water vapor in a staged absorption system.

Plants of this design will produce acid up to 95 percent sulfuric acid strength. Acid transfer by gravity flow eliminates the need for transfer pumps.

The venturi scrubber consists essentially of a venturi tube. Mist-laden gases leaving the low stage absorber are scrubbed in the throat at a high velocity by means of a recirculated stream of dilute sulfuric acid solution. The high degree of turbulence results in practically complete capture of the sulfuric acid mist particles. Entrained liquid leaving the venturi is removed from the gas stream in a cyclone type mist separator.



Flow diagrams of both the standard (A) and new (B) types of contact process plants. Basic differences in design are graphically shown.



General view of the process area of Barnhart Hydrocarbon Corporation's Big Lake plant. Shown are piping and location of major equipment.

THE AUTHOR of this series has developed a system for making light hydrocarbon process plant calculations that utilizes printed forms to expedite the work. Plant engineers and designers normally do a great amount of trial-and-error work in setting up or checking the operation of hydrocarbon processing units. Much of this work can be bypassed through the use of these forms. The calculator in such work may lose a lot of time in planning the order of his computations—in deciding what to do next. Prepared forms help to reduce this time waste by providing an orderly procedure for rating the major equipment items of a process and for making the usual absorption, stripping, fractionation, and vapor-liquid equilibria calculations.

Part I (October, 1950, Petroleum Refiner) treated the basic principles upon which light hydrocarbon process plant calculations and designs are based. This Part II continues this treatment and introduces the first of the printed calculation forms—a sheet for the making of vapor-liquid flash computations and recording the resulting heat and material balances.

A System of Process Calculations For Light Hydrocarbons

Part II. Equilibrium Considerations

A. J. L. HUTCHINSON
Fish Engineering Co., Houston

IN VIRTUALLY all process work the primary interest is in equilibrium between liquids and vapors. As pointed out previously, there is a definite relationship expressed in Raoult's law and our corrections to Raoult's law that definitely tie down the relative composition of a liquid and vapor under equilibrium conditions. This relationship in its simplest form can be expressed by the equation

$$Y/X = K$$

Having a known gas composition by trial and error and the use of the above equation the temperature at which this vapor composition will be in equilibrium with a liquid can be calculated. Such a calculation will not specify the relative amounts of liquid or vapor in the system. This calculation is commonly known as the "dew point calculation." In the nomenclature Y is equal to the mol fraction in the vapor phase and X is equal to the mol fraction in the liquid phase. Therefore, knowing the mol fraction in the vapor phase, or Y, the temperature at any given pressure can be selected so that the sum of the Y's divided by the K's will equal one. This calculation

$$Y/K = X$$

gives the mol fraction of each component in the liquid phase and of necessity if the temperature is correctly selected the sum of all the X's must equal one.

Likewise a certain definite temperature can be assumed and by trial and error determine the pressure at which the sum of the X's will equal one.

As a simple example assume a gas composition as follows:

COMPONENT	Mol. Fraction
Methane	.0208
Ethane	.1742
Propane	.8050
	1.0001

For the first trial assume that it is desired to determine at what pressure we will reach the dew point of this mixture at a temperature at 100° F. The calculation is simplified by setting up a table as follows:

COMPONENT	Mol. Fraction	K @ 100° F. @ 225 Lbs.	X
Methane	.0208	17.8	.0012
Ethane	.1742	2.80	.0622
Propane	.8050	.90	.8944
			.9578

This shows that the first approximation of the pressure, 225 psi., was too low. As a next approximation select a pressure of 235 pounds. The calculation on the basis of this assumption is as follows:

COMPONENT	Mol. Fraction	K @ 100° F. @ 235 Lbs.	X
Methane	.0208	17.1	.0012
Ethane	.1743	2.7	.0646
Propane	.8080	.86	.9340
			1.0018

This shows that the pressure was selected very slightly too high, but close enough for most engineering calculations. This calculation also gives the composition of the liquid in equilibrium with this vapor and this composition would be the composition as shown in the *X* column corrected to a sum of 1.0000 even. The amount of liquid condensed would be too small to affect the vapor composition so the values of *Y* are unaffected.

It can be readily seen that if the pressure were fixed, a similar set of calculations in which the temperature for the selection of the *K* was varied could be followed through in order to determine the dew point temperature at a fixed pressure. This calculation is often used to check gas analysis represented as being obtained under certain temperature and pressure conditions in the field. If a gas analysis is given that under the specified conditions of sampling shows the dew point pressure is less than the pressure given for sampling at the sampling temperature, the analysis must be in error. Likewise, if the temperature given for the sampling pressure is below the dew point temperature the sample must be in error. If the sampling temperature and pressure are at dew point temperature and pressure, the sample may be correct but should be looked upon with a certain amount of skepticism as under these conditions it is possible to have a contaminated sample, and check samples should be taken.

If the composition of a liquid is given the temperature at which this liquid will have a predetermined vapor pressure and conversely the vapor pressure of this liquid at a predetermined temperature can be calculated. The method of calculation is very similar to that given for the dew point except that in this case *Y* is solved for determining the conditions at which the sum of the *Y's* so calculated will equal one. The equation

$$Y/X = K$$

is again used where in this case

$$Y = KX$$

This type of calculation is represented in the following example where it is desired to determine the temperature at which a liquid having the following composition will have a vapor pressure of 250 pounds:

COMPONENT	Mol. Fraction
Isobutane	.1234
n-Butane	.4910
Isopentane	.1194
n-Pentane	.1338
Hexane + (assumed heptane)	.1320

This can be set up in a table similar to that used for dew point calculations. For the first trial the temperature of 235° F. was selected:

COMPONENT	X	K @ 235° F. @ 250 Lbs.	Y
Isobutane	.1234	1.47	.1814
n-Butane	.4910	1.30	.6383
Isopentane	.1194	.87	.1039
n-Pentane	.1338	.65	.0863
Hexane +	.1320	.26	.0343
			1.0442

As the sum of the *Y's* is over one the assumed temperature was too high, so other trials of temperature should be made until the sum of *Y's* is equal to one even.

This latter calculation is commonly known as the "bubble point calculation." It can be readily seen that this type of calculation could be used to determine the vapor pressure that a liquid would have at a predetermined temperature. It must be borne in mind that these two calculations, namely "dew point" and "bubble point," give no indication whatsoever of the relative amounts of liquid and vapor present in the system.

In a great many cases the primary interest is in the amount of liquid and vapor that will result from a certain amount of material passing through any piece of equipment such as a condenser, a flash tank, etc. In this case the total number of mols, the temperature and pressure and the mol composition is known. From this information the amount of liquid remaining, the amount of vapor and the composition of the liquid, and vapor phase can be determined. In considering equilibrium between liquid and vapor it must be kept in mind that it makes no difference from which direction equilibrium is approached, the final equilibrium will be the same. Therefore, one type of calculation will cover the conditions of flashing a liquid into a mixture of liquid and vapor, or condensing the vapor into a mixture of liquid and vapor.

The starting point of this calculation is the same as the dew point calculation, namely,

$$Y/X = K$$

The derivation of the formula for calculation of condensation or flashing is as follows:

Basis 100 mols of inlet fluid
% = mols of any constituent in inlet fluid
N = total mols liquid out
Z = mols of any constituent in liquid out
100 − N = mols of vapor out.

It follows from the above that the summation of all the *Z's* or ΣZ, is equal to *N*.

From the above

$$Y = (\% - Z)/(100 - N)$$
$$X = Z/N$$

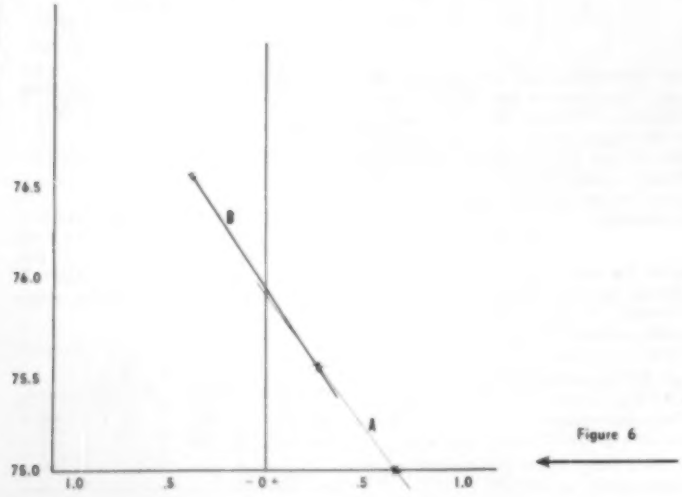


Figure 6

Substituting these values of Y and X in the equation

$$Y/X = K$$

we have

$$\frac{\frac{\% - Z}{100 - N}}{\frac{Z}{N}} = K$$

Solving for Z and putting

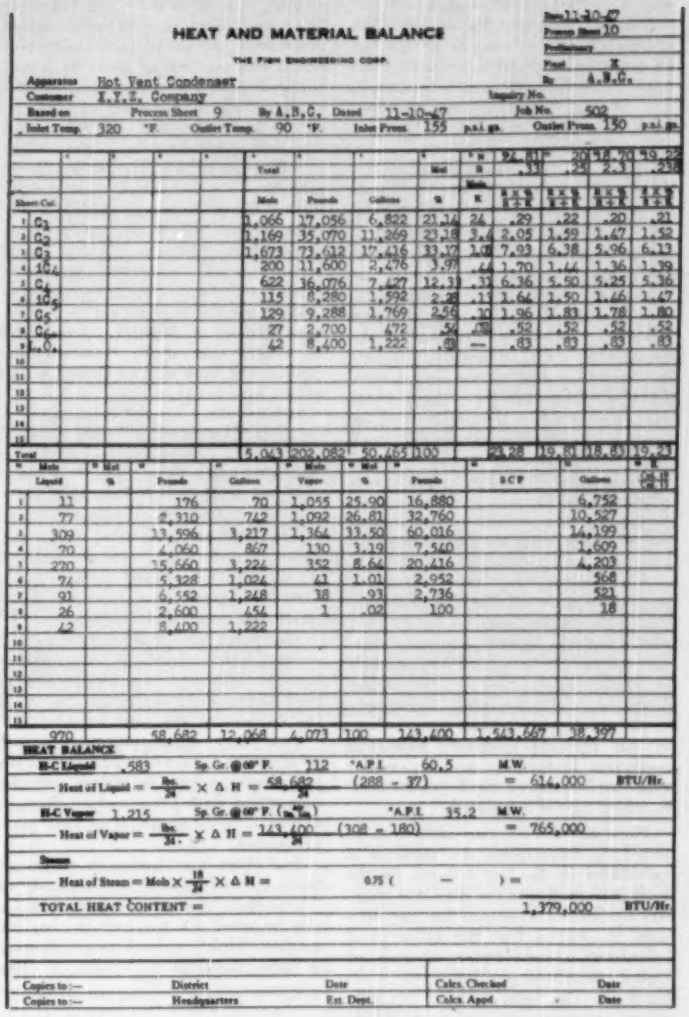
$$N/(100 - N) = R \qquad Z = \frac{R \times \%}{R + K}$$

This is another trial and error calculation.

In solving this equation the percents, the temperature and pressure are known. The *K's* for the individual constituents at the temperature and pressure given are taken from curves. A value of *N*, the total mols of liquid is assumed and *Z*, is solved for. If the sum of the *Z's* so calculated is equal to *N*, the assumption of the value of *N*. is correct. If the sum of the *Z's* is less than *N*, *N* has been assumed too large, and conversely, if the sum of the *Z's* is greater than *N*, *N* has been selected too small. If *N* does not equal the sum of the *Z's* another *N* must be assumed and the calculation repeated. This procedure is followed until the sum of the *Z's* equals, or very closely equals *N*. Experience in the use of the equations will determine for any given problem just how close the sum of the *Z's* and *N's* must be together before the problem is considered as solved.

The example in Table A. below, will show how the equation can be used.

After two calculations are made with assumed values of *N*, provided that the summation of the *Z's* is within less than 5 of the assumed value of *N*, a graph can be made that will give very closely the value of *N* to be used on the third trial. This third trial under these conditions will usually be sufficiently close to the correct answer. This graph is made by plotting the value of *N* against the difference between the sum of *Z's* and *N*, drawing a straight line through these points and using the value of *N* for the third trial at the point where this plot crosses the zero line of the difference between the sums of the *Z's* and *N*. Such a plot for the problem shown in the table is given in Figure 6.



HEAT AND MATERIAL BALANCE

THE FISH ENGINEERING CORP.

Date 11-10-47 · Process Sheet 10 · Preliminary · Final X · By A.B.C.

Apparatus Hot Vent Condenser · Customer X.Y.Z. Company · Inquiry No.

Based on Process Sheet 9 · By A.B.C. · Dated 11-10-47 · Job No. 502

Inlet Temp. 320 °F. · Outlet Temp. 90 °F. · Inlet Press. 155 p.s.i.ga. · Outlet Press. 150 p.s.i.ga.

Sheet Col.																

76.5 is plotted the ΣZ is 76.14. So the difference becomes minus .36. Plot against 76.5 the minus .36. If this latter point is joined with the point computed from 75.5 of + .3 as in line *B*, this crosses the zero line at about 75.96. The third assumption taken of 75.93 gives a ΣZ of 75.96.

Either of the values obtained by these plots is well within the limits of error of the methods of calculations and reading of the *K* values.

The development of the above formula and its application is only for liquids that are mutually soluable in one another. If the liquids are not mutually soluble in one another, the liquid phases will separate into layers and so will not affect the liquid composition. However, the vapor phase will be affected by the presence of the vapor of the nonmiscible liquids. Such a condition exists in nearly all condensations involving the hydrocarbons where the gas has not been dehydrated. Any water that condenses in a condenser under these conditions does not affect the liquid phase of equilibrium, and by Dalton's law only affects the partial pressures of the hydrocarbons. Therefore, in figuring a condenser where water is present the vapor pressure of the water at the temperature of condensation must be subtracted from the total pressure on the system. If the condensing temperature is low, or our pressure relatively high this correction factor often becomes smaller than can be read on the *K* value curves in which case it is ignored.

The number of liquid mols is computed by multiplying the value of *Z* calculated in the last column by the total inlet mols and dividing this quantity by 100. The reason for the division by 100 is that the value of *Z* calculated is the number of mols of liquid condensed per 100 mols of inlet fluid. The total number of mols condensed must likewise equal ΣZ in the last column times the total number of inlet mols divided by 100. The mols of vapor remaining after condensation is the mols of inlet of each constituent minus the number of mols of liquid condensed. As a check on the accuracy of the whole computation we can calculate from the mol percent liquid and mol percent vapor the corresponding *K* values. The *K* values so calculated should check closely with the *K* values originally used for the computation. Where the mol percents are small in either the liquid or vapor phase, these *K* values may not check exactly as the computations of percentage are not carried out to a sufficient number of decimal places to get an exact value of *K*. However, this method will show up any large discrepancies in the values.

A form sheet for the calculation of vapor and liquid equilibrium suitable for use in condensation and flash calculations has been set up. This form is shown in Figure 7. This form sheet provides columns for conditions where several streams enter the equipment under consideration with the sum of all the streams entered in column 5. The form provides spaces for the "trial and error" calculation.

The form also has columns for weights and volumes of all fractions together with the totals. On the bottom part of the sheet spaces are provided for computing the heat balance.

This sheet contains all the essential information from which heat exchanger specifications can be drawn, or the amount of flash taking place through a motor valve ahead of a flash tank calculated.

For those who prefer to make all their calculations on the basis of "Total Mols" the same general equation can be used. In this case in the line marked "Mols" under *N* assumed, enter *N* times the total of column 5. Then in the formula $\frac{R \times \%}{R + K}$ substitute "Mols" for "%" making the formula $\frac{R \times \text{Mols}}{R + K}$

Then ΣZ for the correct assumption of *N* will equal the mols assumed at the top of the column.

In order to figure vapor pressures of mixtures it is sometimes desirable to know the apparent vapor pressure of a constitutent when in solution.

Setting up Raoult's law equation for actual solutions:

$$\pi Y = P_t X$$

and rearranging into the form:

$$P_t = \frac{\pi Y}{X} = K\pi$$

and using *K* as read from the curves P_t will not equal the vapor pressure of the pure compound as read from vapor pressure curves but will be the apparent vapor pressure of the pure material under the conditions of equilibrium. The ratio between P_t and the true vapor pressure of the compound is known as the Raoult's Law correction factor.

$P_t = FP$
P_t = apparent vapor pressure
F = Raoult's Law correction factor
P = vapor pressure of pure compound

As an example of what is meant by Raoult's Law correction factor, assume the condition of 700 pounds absolute and 100° F. for isobutane. The *K* value under these conditions is .195, then $.195 \times 700 = 136$ pounds as the apparent vapor pressure. The actual vapor pressure of pure isobutane at 100° F. is 80 pounds, therefore, Raoult's Law correction factor:

$$F = \frac{136}{80} = 1.7$$

The apparent vapor pressure is, therefore, 1.7 times the true vapor pressure under these conditions.

In a great many cases it is necessary to figure out how much liquid and how much vapor, and the compositions of the liquid and vapor resulting from flashing a liquid from one pressure to a lower pressure when only the inlet pressure and temperature of the liquid and its compositions is known. In this case some temperature at the lower pressure is assumed and the equilibrium conditions for this temperature are calculated. Using the results of this calculation of the liquid and vapor figure the heat content of the liquid and vapor above some base temperature; likewise calculate the the heat content above the base temperature of the entering liquid at its temperature before expansion. If the sum of the heat contents of the vapor and liquid after flashing equal the heat content of the liquid prior to flashing, the assumed temperature is correct. If this assumed temperature does not give a heat balance around the unit a new temperature must be assumed and the calculations repeated: if the sum of the heat contents of the

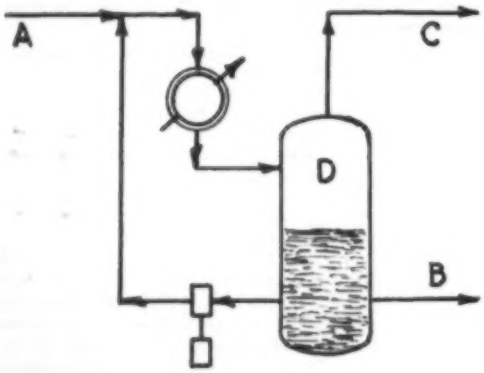
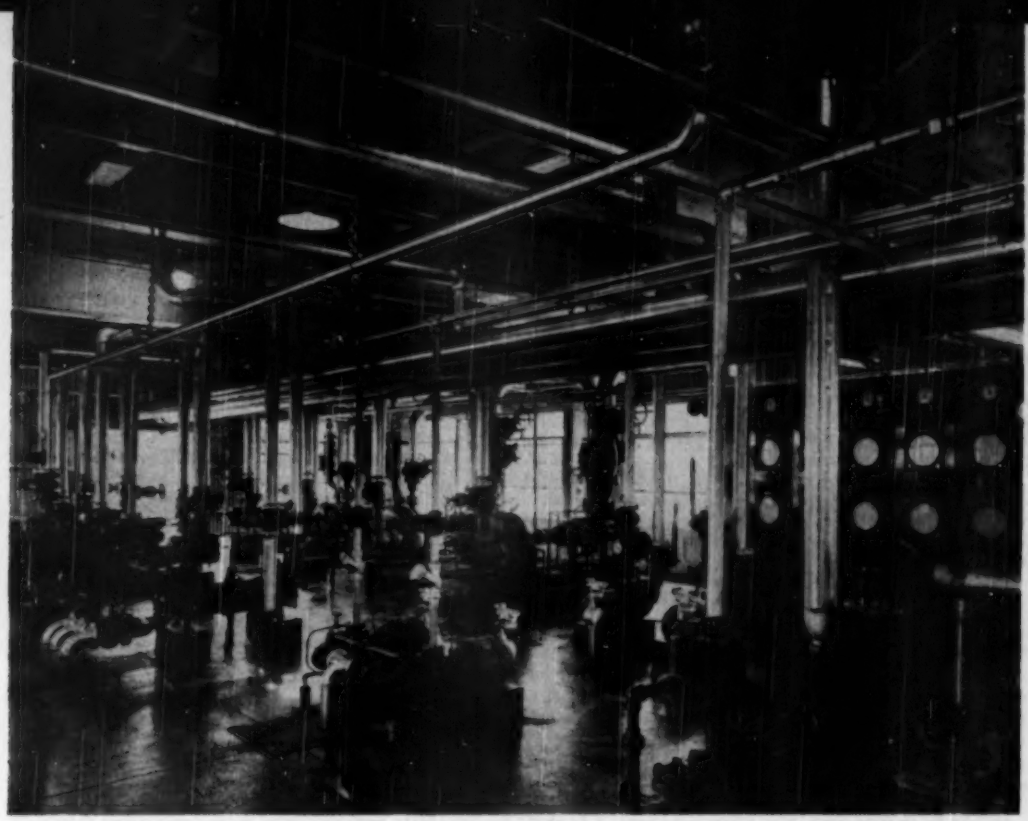


Figure 8



Pumphouse interior and control panel of Dubach, Louisiana, plant of Southwest Gas Producing Company, Inc.

liquid and vapor exceed the heat content of the liquid before flashing the assumed temperature after flash is too high.

In evaluating heat exchangers and the amount of flash that takes place in the heat exchangers, assume that the oil being cooled through the unit will give up a definite amount of heat. Stated another way—fix the decrease in temperature of the oil being cooled and compute the heat given up by this oil to the oil being heated and vaporized. Assume then the outlet temperature of the oil being heated at the pressure conditions at this point and compute the flash.

Next figure the total heat content of the combined liquid and vapor, and from the heat content of the oil entering the heat exchanger, compute the total heat absorbed by this oil stream. The heat absorption of this oil must equal the heat lost by the oil on the other side of the tubes in the unit. This again is a trial and error calculation and must be repeated until the two heats balance. It is often advisable to plot the temperature against heat increase in the oil in order to assist in arriving at the correct temperature with the minimum number of calculations.

In a system in which the preheater directly follows the heat exchangers and any vapors generated in the heat exchangers pass directly through the preheater, calculate the total flash as if the composition to the preheater were the same as that entering the heat exchanger. The fact that a mixed phase enters and leaves the preheater has no effect on the final equilibrium at the outlet of the preheater. The heat load on the preheater is the total heat put into the oil passing through the heat exchangers and preheater, less the heat put into the oil in the heat exchanger.

If, however, a flash tank is used between the heat exchanger and preheater and the vapors withdrawn from the system at this point, the flashing in the preheater is figured solely on the basis of the composition of the liquid oil entering the preheater. In this case the heat load on the preheater is the difference in heat content of the liquid and vapor leaving the preheater and the heat content of the oil entering. If a comparison is made between the compositions of the oil remaining after flash in the first case and second case, it will be found that in the second case there is a larger volume of liquid oil than in the first case. This is similar to the common practice used of flashing high pressure condensate or crude oil by multiple staging in traps instead of flashing, the total volume, to a low pressure in one stage. By multiple stage flashing is meant reducing the pressure in a series of flash tanks from the initial pressure to the final pressure.

Where a high-pressure liquid is flashed down in a series of stages it will be found that the liquid in the outlet of the low pressure trap will contain a much larger percentage of gasoline fractions and also be larger in volume than if the flashing had all taken place in a single unit.

As a corolary of this in the multiple stage flashing the gas volume will be less than in case of single stage flashing and will contain less gasoline fractions.

It is desirable to keep the pressure drop through a preheater as low as possible. If the pressure drop through the preheater is high, vaporization in the preheater is retarded with the result that additional flashing takes place after the fluid leaves the unit causing a drop in temperature which may seriously affect the operation of the still.

In the system shown in Figure 8 a vapor passes through a condenser into a receiver. From the bottom of

this receiver condensed hydrocarbons are withdrawn and from the top of the receiver uncondensed vapors. This is a normal condensation system. A great deal of confusion is caused in the minds of a lot of engineers as to what would happen if we pump a stream of this condensate back into the vapor line entering the condenser.

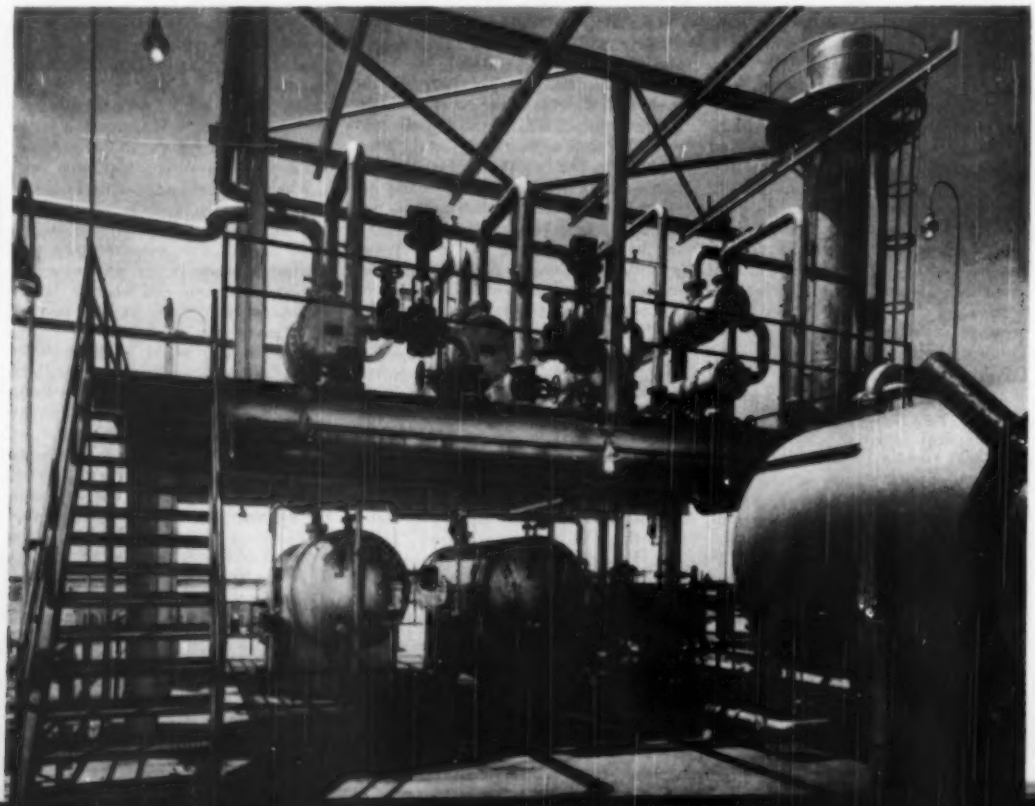
At first glance it would appear that because the material condensed being heavier than the average of the material entering at *A*, that this would cause greater condensation to take place in the condenser resulting in a greater withdrawal of liquid at *B* and less vapor at *C*. However, if this is analyzed it can be seen that returning this liquid back to the inlet of the condenser will have no effect on the volume or on the composition of *C* and *B*. It is assumed in this discussion that the composition of *A* remains constant and the temperature and pressure in accumulator *D* remains constant. The temperature and pressure at *D* define the relative compositions of the streams *B* and *C*, but do not define exclusively the volume of *C* and *B*. The only thing that defines the volume at *C* and *B* is the composition and the volume at *A*. If the liquid returned to the inlet of the condenser is initially in equilibrium with the vapor *C*, in effect all that has been done is to increase the volume of liquid entering receiver *D*, but not to change the composition of the liquid entering receiver *D*. Therefore, the composition of stream *C* cannot change and as the volume of stream *C* is defined by stream *A*, and the temperature and pressure at *D*, nothing has been introduced to the system to change stream *C*. If stream *C* is not affected, by the same reason stream *B* cannot be affected. Therefore, recycling this condensate back to the inlet of the condenser will have no effect on the composition or volume of streams *B* and *C*. If, however, a portion of the liquid in receiver *D* had been withdrawn and passed through some other process in order to remove the lighter constituents, as through a stabilizer, and returning only the heavier constituents back to the inlet of the condenser, a change would then have been made in the equilibrium conditions existing in *D* thereby resulting in a variation in the composition and volumes of streams *B* and *C*; increasing stream *B* and decreasing stream *C*.

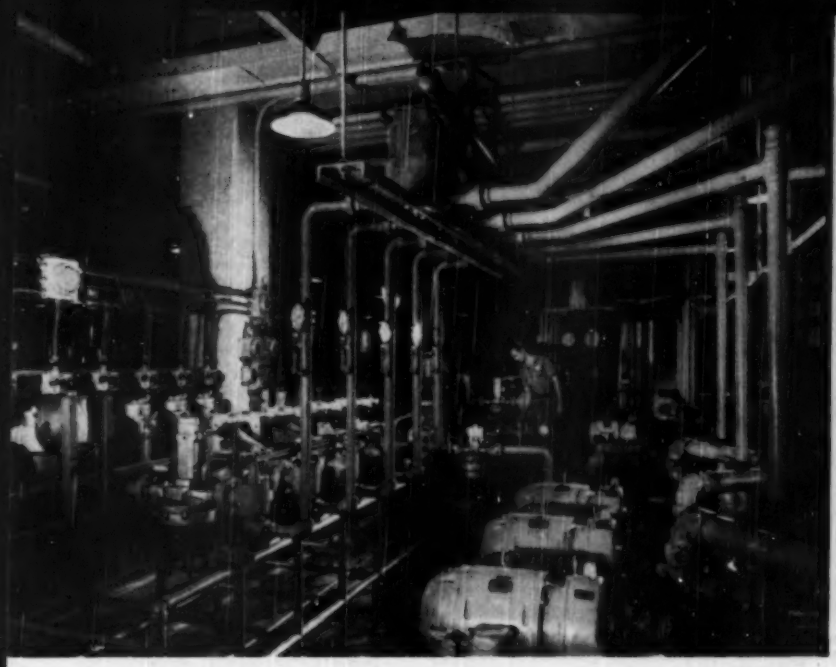
It has been shown previously how to convert mols of vapor or gas to cubic feet. There is no such simple relation between the number of mols of a liquid and the gallons occupied by the given number of mols. Each compound has a different conversion factor to convert from liquid mols to liquid volumes. This factor is a function of the liquid specific gravity of the pure hydrocarbons and its molecular weight, by the weight per gallon of the pure compound to obtain the gallons per mol corresponding to that compound. As an example calculate the gallons per mol of propane. Liquid propane at 60° has a specific gravity of .505. Therefore, its weight per gallon is $8.33 \times .505$. That is equal to 4.22 pounds per gallon. The molecular weight of propane in round numbers is 44, so the gallons per mol of propane is equal to 44 divided by $4.22 = 10.41$.

Methane and ethane do not show a constant gallons per mol for all percentage mixtures. The actual gallons per mol for any given mixture can be calculated, but in most cases the actual volume of the methane and ethane in the liquid is so small that such a calculation is not necessary and an average value for converting from mols to liquid volume can be used.

End of Part II. Part III will appear in an early issue.

Coolers for the overhead vapors from fractionating columns in Barnhart's Big Lake, Texas, plant are elevated in the steel structure alongside the columns. Reflux accumulators are situated below the coolers on the roof of the pumphouse.





Automotive and industrial lubricants are blended from several lube base stocks and include certain additives. To maintain the exact proportions of lube base stock and additives, proportioner metering equipment is used in blending operations. Mechanically proportioned, the oil at the Cities Service Chicago plant flows to storage, where it is batch-tested before packaging.

New Oil Blending Plant

One of Largest in Country

CITIES Service Oil Company has started operations at its new Chicago terminal and compound plant, which will compound, blend, package and ship 25 million gallons of lubricating oil annually. Located approximately seven miles southwest of the Chicago Loop, the plant is on a 42-acre tract east of Cicero Avenue and north of the Ship Canal.

Base oils used at the Chicago plant are transported there by barge from the Cit-Con refinery at Lake Charles, La. The two-barge tow arrangements used for the 3200-mile trip are especially designed for the job. Each barge has eight compartments and handles 670,000 gallons of lubricating oil stock.

Outside tankage for storing base stocks and additives at the Chicago plant consists of 42 units of from 10,500 to 420,000 gallons capacity, with a total capacity of 7 million gallons. Each tank is equipped with a suction heater and an individual section line to the transfer pump room. Oil in the tanks is protected against contamination by condensed moisture by a blanket of fan-forced air dried by passage through beds of activated alumina.

The main building is 450 feet long by 140 feet wide, has a full basement, and varies in height from one to four stories. The building is a reinforced concrete frame structure, with concrete floors and masonry walls, both interior and exterior.

Main unloading units are two 18 x 14 x 18-inch duplex reciprocating steam pumps; a 7½ x 6 x 10-inch pump is also available for priming purposes if conditions should require its use. An unusual arrangement on the barge unloading equipment is a heat exchanger through which a portion of the discharge stream can be diverted, heated and returned to the barge for the purpose of raising the temperature of the oil. This exchanger uses discharge steam from the pumps and is intended to be used only when oil in the barge is highly viscous as a result of low temperature. The discharge system from this pump installation to the storage tanks consists of one 10-inch, two 8-inch and two 6-inch lines. Provision was made on these lines for the use of "pigs" for purging the lines to avoid any mixing of oils.

All outside process and steam piping is installed in reinforced concrete pipe ducts, the top of the ducts being composed of removable pre-cast light concrete slabs. The pipe ducts have fin-type steam radiators to maintain temperatures which will reduce radiation loss from the heated oil during cold weather. Certain lines, which handle highly viscous oils are steam traced and insulated.

All transfer pumps are in a pump room in the main building basement. These pumps are of the Tri-Rotor type and the battery includes seven units of 200-gallon-per-minute capacity and seven units of 100-gpm. capacity. No permanent piping connections are used on any of the pumps; flexible hose and swivel type pipe assemblies with "quick couplings" are used for both the suction and discharge connections.

Two five-meter proportioner systems with homogenizers are used for the continuous blending of lubricating oils. Each of these systems has a rated capacity of 125 gpm. at maximum viscosity of 1200 Saybolt Seconds Universal. The blended

A scene in one corner of the laboratory at the new plant. Each batch of blended oil is tested and certified as to conformance with specifications before the batch is released for packing or shipment.

oil from the proportioner systems is piped to storage tanks located in the top portion of the compound building. In addition to the proportioner systems, batch blending is carried out in 32 kettles ranging in size from 378 to 1680 gallons located on the third floor of the building.

In the top portion of the building are 52 vertical shop-built tanks, varying in capacity from 4200 to 12,600 gallons, total volume being 378,000 gallons. Five 4200-gallon and four 12,600-gallon units have permanently installed mixers and can be used for blending if desired. Twenty-four of the 52 tanks are located in a hot room, where temperatures up to 100° F. can be maintained. These tanks are used for the storage of additives and of very viscous oils which can be satisfactorily blended only at higher temperatures.

A laboratory on the second floor is fully equipped for making all physical and chemical tests on lubricating oils. Each batch of blended oil is tested and certified as to conformance to specifications before the batch is released for packaging or bulk shipment.

Blended oil flows by gravity from the overhead tanks to filling lines located on the first floor. The plant's conveyor system has a total length of approximately one mile. This system handles empty cans and drums from either the railroad or the truck docks to storage areas in the compound building. From this point conveyors carry the empty packages and containers through the various filling lines. The filled containers are carried to storage or to the docks for rail or truck shipments. Miscellaneous movement of finished goods is handled by lift trucks equipped with forks for pallet movement, or barrel clamps for handling drums.

Steam for processing, operations and building heating is produced by two package-type boilers having a total capacity of 40,000 pounds per hour. These boilers are equipped with combination oil-gas burners. Located adjacent to the boiler room is a 500 cubic feet per minute, 75 psig. compressor which furnish air for instrument operations and for general plant use.

The network of overhead piping comprises a manifold which permits the filling of drums or other containers with any of a large number of scientifically-blended lubes.

This five-quart can filling and closing machine at the compound plant has a capacity of 35 cans per minute. The filling line for one-quart cans handles 300 per minute.

Catalytic Cracking

MARSHALL SITTIG

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PART IV

THE Suspensoid process was developed by Imperial Oil Company, Ltd., of Canada and is operated by them at their Sarnia, Ontario, refinery.[125]

Particularly from the equipment standpoint, it is most closely related to conventional thermal cracking practice. It is not only similar equipmentwise to thermal cracking equipment but also represents a compromise between thermal and catalytic cracking in product yield and quality.[125] A good margin of improvement over thermal cracking is obtained at a cost much less than that for other catalytic methods. Additional operating costs over thermal cracking are estimated at 12 cents per barrel of fresh feed[125] and savings in tel. alone should justify this cost.

A small amount of pulverized clay catalyst is slurried with the charge stock and pumped through the fired cracking coil. Converted tube and tank cracking units comprise the equipment at Sarnia. A flow diagram of the process is shown in **Figure 8.**

Spent Filtrol from the lube oil plant (100 percent through 100-mesh) is stored in a bin. A bucket conveyor carries it to the cone-bottomed feed bin suspended above the slurry tank. Two pounds of catalyst per barrel of feed are added to the hot charge in the form of a gas oil-clay slurry.

Synthetic clays have been demonstrated to be superior to natural clays in this process but their cost without regeneration is prohibitive. Since the catalyst in the present process is essentially a waste product already, it is discarded after a single pass.

Fresh Filtrol is more active than the spent variety from the lube oil plant but not sufficiently greater in activity to warrant its use when spent clay is available.[125] Incidentally, the spent Suspensoid catalyst has very little activity. Catalyst cost alone in the Suspensoid process is estimated at 4-5 cents per barrel of fresh feed.

The clay-oil mixture enters the coil at 500-550° F. and is heated to 1040-1060° F. at 400-500 psi, where total vaporization takes place. The gas oil charge may be diluted with 25 percent naphtha to insure complete vaporization. In this connection, it is interesting to note that original work in the development of this process consisted of merely injecting clay into the regular thermal cracking coil. However operation at thermal cracking conditions gave little advantage over straight thermal operation. When temperature and pressure were altered to insure complete vaporization, much better results were obtained. Also the coke formation in liquid-phase operation of this process is prohibitive.

PART IV, the concluding installment of this series on catalytic cracking, contains a section on the Suspensoid cracking process and a discussion of the relative merits of the fixed-bed and moving-bed processes.

Other sections deal with the effect of process variables on conversion, factors affecting product distribution and product quality, and the finishing of catalytically cracked gasoline. Cracking catalyst, composition, properties, and manufacture also are discussed as is laboratory work on catalytic cracking, pilot plant development, and plant control.

As a result of the higher temperature and the catalyst, conversions of 80-90 percent based on the coil charge are obtained in the Suspensoid process.

The furnace transfer line passes directly to a flash chamber where the charge is quenched to 750° F. with 35-40 percent of its own weight of gas oil. Vapors from the flash chamber are fractionated to the desired specifications.

The tar-catalyst mixture in the bottom of the flash tower flows to a receiver and thence to Oliver pressure rotary filters. A one-inch precoat layer is employed which lasts for 50-60 hours. Filter rates of 25 gallons per square foot per hour are typical in this catalyst separation step. The filtration is conducted above the flash point of the tar so a pressure of 15-20 psi, is maintained within the filter jacket by means of flue gas.[124]

The tar (10-12° API) from the filters is used as fuel oil and the catalyst discarded. The fuel oil is of particularly high quality because salts and carbon are removed in the filtration step. The clay may be used as a fill for low spots in the refinery area.[125]

Just as in Fluid cracking, this process, which essentially employs fluidized solids in the cracking coil, offers a considerable erosion problem.

Furnace coil erosion is only slightly more than in simple thermal cracking. The problem of erosion in a pressure release valve beyond the heater was solved by simply using a small converging orifice discharging directly into the flash chamber. Other points at which erosion problems were solved were at the Oliver filter and at the slurry pump. A special gland on the filters through which clean oil flows

continuously helps keep clay out of the bearing surfaces and prevents leakage. A special triplex slurry charge pump having a gland seal to prevent catalyst lodging in the packing is used.

In general, the best results have been obtained with the Suspensoid process when the lowest temperatures and longest contact times compatible with complete vaporization are used. Gasoline yields of 52-58 percent of 73-75 ASTM octane number (which can be brought to 93 with 3 cc. of tel.) are obtained.

During World War II, a so-called Supersuspensoid operation was carried out to produce large quantities of butylenes.[125,126] This was a deeper cracking operation and was conducted at temperatures up to 1090° F. at the coil outlet and about 250 psi. pressure. The high temperatures and lower pressures gave rise to higher furnace coil velocities with correspondingly greater erosion. Special streamlined headers were incorporated in the furnace coil and a stainless steel collar fitting between header and tube and protecting the last three inches of the tube from erosion was employed.

Hydrocracking and Hydroforming

Hydrogenation was at one time (1930), regarded as basic to the petroleum industry because it could produce more than twice as much gasoline as existing processes and because its use would extend the oil reserves of this country which were then thought to be dwindling. However, subsequent discovery of large additional crude supplies minimized the essentiality of the hydrogenation process for an indefinite period and very few companies have built the expensive plants necessary to operate this process.[127]

While hydrogenation has not been widely utilized in the manner originally anticipated, it has been a vital process in the development of 100-octane gasoline. The first substantial quantities of synthetic aviation gasoline base stock were made in a large hydrogenation plant operated by Standard Oil Company of Louisiana at Baton Rouge. This plant added pure hydrogen to diisobutylene to make isooctane; hence it was not a cracking plant and is outside the scope of this paper. The introduction of this fuel to the market spurred on petroleum research however, eventually resulting in the evolution of the present-day catalytic cracking processes.

Hydroforming, or hydro-reforming, is a catalytic cracking process and is important in the production of synthetic toluene.[128] In general, a 45-55 ASTM naphtha feed is the charge stock and a gasoline product (80-90 Research) high in aromatic content is obtained in 75-90 volume percent yield.[5] Prior to the war, three hydroformer installations existed and during the war five additional plants were built, primarily for the manufacture of toluene for the TNT plants. The economics of the hydroforming process are marginal under present conditions for gasoline manufacture in the average refinery but low-value charge stock or other conditions may make it attractive in specific applications.[5] In wartime manufacture of toluene of course, the nation's need outweighed any problems of economics.

The hydroforming process is interesting in that, although hydrogen is essential to the process, no outside source of hydrogen is employed, but rather hydrogen is generated in the cracking unit through dehydrogenation reactions and recycled. The basic aim of the hydroforming process is to dehydrogenate naphthenic hydrocarbons and to convert straight-chain hydrocarbons into cyclic hydrocarbons, naphthenes or aromatics by catalytic action.[129] The fresh naphtha feed is heated to reaction temperature (1000° F.), first by heat exchange with the products and then in a furnace as shown in **Figure 9.** At the entrance to the reactor which operates at 150 psi., the hot vapor is joined by recycle gas containing 40-80 volume percent hydrogen, depending on feed stock, catalyst, and reactor conditions. Two-pass operation is recommended.[129,130] The gas out of the reactors passes to a gas-separation system where recycle gas is produced and from which the liquid product is sent to final fractionation.

Operating conditions for the hydroformer at the Oleum refinery of Union Oil Company of California have been given by Hartley:[130]

Reaction pressure	150-300 psi.
Reactor charge temperature	1000-1070° F.
Wet gas recirculation (70% hydrogen)	6000 cu.ft./bbl. reactor chg.
Dehydrogenation catalyst	10% molybdenum oxide on alumina
Space velocity — Vol. feed/hr./reactor / Vol. catalyst/reactor	0.6
Contact time	about 15 seconds

As in the other fixed-bed cracking processes already described, provision must be made for periodic catalyst regeneration. Due to the reduction of coke formation in the presence of hydrogen, fairly long on-stream periods are permissible. The time distribution over the 6-hour cycle in one plant[131] is as follows:

On stream	245 minutes
Regeneration	90 minutes
Purges and valve changes	25 minutes

At the end of the cracking period, hydrocarbon feed is diverted to another reactor and the reactor coming off stream is vented off and then evacuated to 25 inches Hg vacuum whereupon it is repressured with inert gas. Air is added to this stream entering the spent reactor at controlled rates and regeneration gases pass to a waste-heat boiler. When coke combustion is complete, the reactor is depressured and evacuated to remove inert gas, following which it is repressured with feed gas and the hydroforming reaction begins again.

A portion of the hydrogen-rich gas produced in the hydroforming reaction is used to blanket the feed system to prevent the introduction of any oxygen, since oxygen has been found responsible for fouling of heat exchangers with solid reaction products.

In early operation of these hydroforming plants a reheat period was deemed necessary following the regeneration step. Only 1.5 percent oxygen is employed in the regeneration gas[130] and the heat of regeneration is removed by the excess inert gas. This resulted in a cooling effect at the end of regeneration which produced a catalyst temperature too low for the start of the cracking cycle. However, careful control of oxygen content at the end of regeneration has resulted in sufficiently high temperature for satisfactory conversion at the start of the next cracking period and this reheat period has been eliminated in some plants such as the one for which the operating cycle is given above.[131]

The reactors employed in the catalytic reformer at the Richmond refinery of Standard Oil Company of California are of special design and are worthy of special mention. Each vertical reactor contains ten catalyst trays, each three feet in depth. An annular space exists between the reactor shell and the rims of the trays so that they essentially operate in parallel. Feed enters the reactor around the waist of the shell, flows upward and downward in the annular space and passes through the catalyst beds, discharging into a central duct. Entrance to this duct is controlled at the various bed levels by orifices to assure even distribution of the gases over the entire catalyst.[131] Good hydrocarbon distribution, low velocity, and low pressure drop are features of this type of construction. This low pressure drop is important in the regeneration step since it increases the coke burning capacity of the unit for a given blower installation.

An impregnated molybdena-alumina catalyst was tried in early work but a co-precipitated catalyst proved much better and at the close of World War II was used in 75 percent of the catalytic

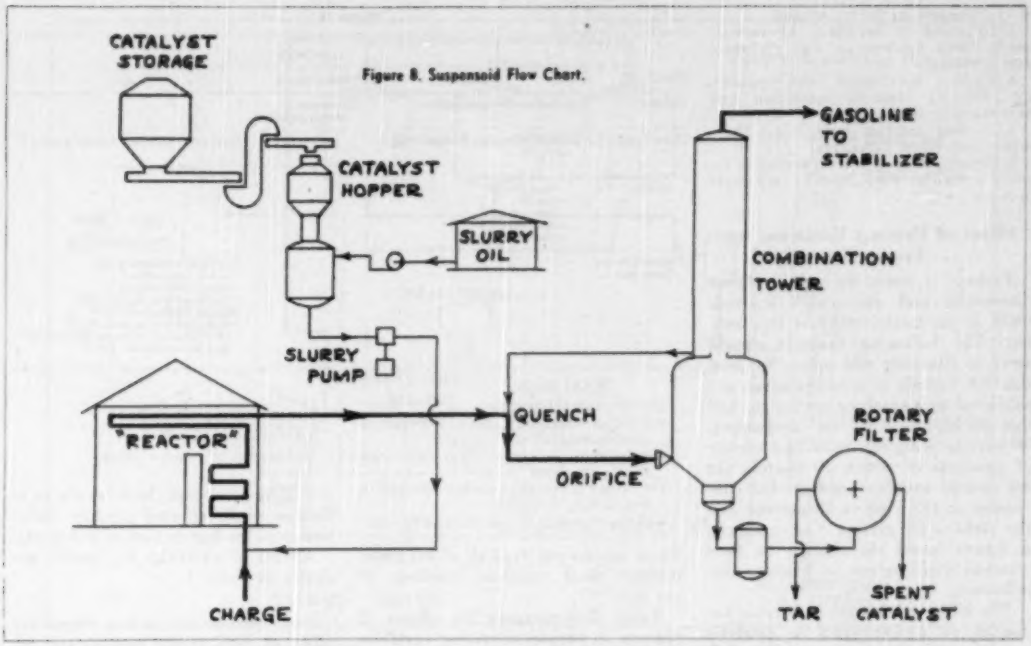


Figure 8. Suspensoid Flow Chart.

reforming plants in this country. Runs of 22 months with substantially no loss in conversion or breakage to fines have been reported.[121]

So much for hydroforming. Sachanen[7] presents an excellent treatment of hydro-cracking and due to the unfavorable economic position of this process at present, it will not be discussed further here.

Fixed-Bed vs. Moving-Catalyst Processes

Fixed-bed processes (Figure 10, page 131), are stated[120] to have the following advantages over moving-catalyst processes:

1. No appreciable catalyst loss through the formation of fines by abrasion.
2. Elimination of equipment for circulation, separation, and recovery of catalyst from process or reactivation gases.
3. Flexibility in permissible operating pressures over a relatively wide range.
4. No apparent tendency for high-boiling, non-volatile reaction products to condense on and bond the catalyst since contact between catalyst and reaction products is limited to relatively high-temperature zones.
5. Ease of adaptation to present equipment.
6. Exclusion of catalyst fines from oil product.

In general, the needs of catalytic cracking processes (whether best served by fixed-bed or moving-catalyst processes) may be summarized as follows:[29]

1. Supply of heat when and where required.
2. Removal of heat during regeneration.
3. Catalyst purge to avoid mixing of air and oil streams.
4. Distribution of reacting vapors uniformly over the catalyst.
5. Prevention of buildup of excessive catalyst deposit hindering reaction.

A process has been patented recently which is claimed to combine the advantages of fluidized-solid and moving-bed processes without their disadvantages.[122] The reactor is mounted on top of the regenerator. Oil vapors pick up catalyst from the bottom of the regenerator and carry them to the top of the reactor. A cyclone at the top of the reactor drops the catalyst into the reactor and separates the gases which are then reintroduced to the bottom of the reactor where they contact the catalyst countercurrently. A central conduit within the reactor is internally fired and serves to heat the reaction mass. Spent catalyst drops from the reactor to the regenerator where it is reactivated by a countercurrent stream of air. No complicated mechanical conveyor systems and no balancing of catalyst flow in reactor against that in the regenerator are involved in this process.

Hougen and Watson[124] present an interesting discussion of the pros and cons of the fluidized bed vs. the pelleted (fixed or TCC) bed. Ease of regeneration favors fluidized operation but the authors emphasize that due to low fluidization velocities, a short, broad bed is necessary which in turn results in longitudinal mixing. Such mixing is undesirable because it requires a larger bed for a given conversion but even more undesirable from the standpoint that the extent of secondary reactions is increased. This occurs because the good mixing causes the entire bed to assume an essentially identical condition, approximating the outlet condition. Lower conversion and poorer selectivity result than with the use of a fixed bed and the same weight of catalyst in the reactor per unit feed rate. Thus fluid reactor operation approaches fixed-bed operation at a very low mass velocity. These undesirable results of mixing may be offset by the higher effectiveness factor of the powdered catalyst. However, the larger void fraction present in a fluidized reactor leads to more uncatalyzed reactions in the gas phase.

Hougen and Watson[124] also list the various ways in which temperature control may be achieved in a catalytic reactor. It is interesting from our standpoint to annotate their list with the various catalytic cracking processes as they fall within this classification. As may be seen, temperature control methods give one approach to classification of the processes described in this paper. These methods involve:

1. The use of adiabatic sections with intermediate heat exchangers, e.g., newer Thermofor zone-type regenerators.
2. Addition of an inert heat carrier to the gas stream, e.g., regeneration steps

in cycloversion or hydroforming.

3. Injection of reactants at various points along the reactor, e.g., cycloversion reactors.

4. Control by lateral heat transfer, e.g., Houdry reactors employing salt heat-transfer tubes.

5. Moving catalyst beds, e.g., Thermofor and Fluid processes.

6. Employment of the regenerative reactor principle, e.g., Houdry adiabatic process.

Effect of Process Variables on Conversion

Perhaps it would be well to define conversion and distinguish it from yield as an introduction to this subject. The following example should serve to illustrate this point. Suppose that 100 barrels of a hydrocarbon are subjected to a cracking operation, and that 60 barrels come out unchanged, 40 barrels being converted to a variety of products of which 10 barrels are the desired gasoline product. The conversion in this case is 40 percent and the yield is 25 percent. Conversion is a figure based on change in feed whereas yield refers to product distribution.

The effect of changes in various variables on conversion in catalytic cracking may be summarized as follows:[135]

1. Temperature. An increase in temperature increases conversion.

2. Pressure. An increase in system pressure results in increased conversion in the lower pressure ranges.

3. Space velocity. A decrease in space velocity increases conversion. Space velocity may be expressed in various ways:

a. Liquid hourly space velocity—Ratio of liquid volume of oil charged per hour to volume of catalyst.

b. Weight hourly space velocity—Ratio of weight of oil charged per hour to weight of catalyst.

Usual space velocities are 0.1 to 10.0 weights of oil per weight of catalyst per hour.

4. Process period. Decrease in length of process period serves to increase conversion. The process period may be as short as one minute or as long as several hours.

Factors Affecting Product Distribution

Product distribution may be defined as the relative yields of the various fractions in the total product at any given conversion level.

The factors affecting product distribution are as follows:[135]

1. Type and activity of catalyst
2. Conversion level
3. Temperature
4. Quality of charging stock

Variation in product distribution with an increase in conversion may be summarized as follow:

Dry gas (C_2^-)—increases at an increasing rate.

C_3—increases linearly.

Butylenes—increase, pass through a maximum, fall off.

C_4—increase but at a lower rate than the C_4 fraction.

Gasoline—increases, passes through a maximum, falls off.

Coke—increases at an increasing rate.

These results are typical of the once-through fluid catalytic cracking of gas oils.[135]

Table 3 summarizes the effects of changes in various operating variables on product distribution.

In connection with the table, it should be noted that stocks of low characterization factor may show little change or even an increase in gasoline with increased temperature.[135] Also increased temperature gives more dry gas and less coke as shown, but in addition increases total coke plus dry gas in spite of the decrease in coke formation.

TABLE 3

CONSTANT	VARIABLES		
	Temperature	Space Velocity	Catalyst
Catalyst	An increase decreases gasoline	An increase decreases gasoline	
Space Velocity	More active catalyst decreases temperature[152]		More active catalyst increases gasoline[87]
Conversion and Catalyst	Increased temp. gives: —more dry gas —less C^5 —less gasoline —some more C_4's —less carbon		
Temperature and Conversion			More active catalyst gives: —better distribution —more liquid recovery —higher gasoline/dry gas ratio —higher gasoline/coke ratio —little change in percent coke[87] —little variation in dry gas although there may be a maximum value[87]

Factors Affecting Product Quality

Product quality refers to the proportions of paraffins, olefins, naphthenes, and aromatics in any product fraction. Thus, conversion has told us how much total product we get, product distribution has told us how many barrels of each of these commodities there are in the product, and product quality will tell us the chemical nature of the contents of each of these barrels.

Product quality is affected by:[135]

1) Type of catalyst.
2) Conversion level.
3) Temperature.
4) Quality of charge stock.

It will be noted that these are the same factors which affected product distribution in the last section of this paper.

Effects of variables on quality are shown in Table 4.

Sour feed stocks have a depressing effect on both octane number and tel. susceptibility of product gasolines from catalytic cracking operations.[4]

The generally high olefinic content of catalytically-cracked gasolines is reflected in lead susceptibility and in high CFR-R octane numbers (85-96 clear).[4]

Finishing of Catalytically-Cracked Gasolines

Finishing of gasolines from catalytic cracking which may contain excess olefins may be accomplished in a variety of ways.[135] The gasoline product may be contacted with a synthetic silica-alumina catalyst in a second unit at 700-900° F. Sulfuric acid treatment may be employed. Lead susceptibility of the gasoline product is improved by combined olefin and sulfur removal in this process. However it possesses three disadvantages when compared with

TABLE 4

PRODUCT	Quality	FEED STOCK			OPERATING CONDITIONS					
		U.O.P. "K"	Percent Sulfur	Percent Conv.	Temp.	Space Rate	Catalyst Oil Ratio	Steam Oil Ratio	Press.	Catalyst Activity
Gasoline	Olefin Content	Incr.	None	Decr.	Incr.	Small	Small	Incr.	Decr.	Decr.
	Aromatic Content	Decr.	None	Incr.	Incr.	Incr.	Small	None	Small	Decr.
	i-C_4 Content	Decr.		Incr.	Small Decr.					
	i-C_5 Content	Decr.		Incr.						
Dry Gas	CH_4-H_2 Content				Incr.					
	Olefin Content	Incr.			Incr.					

Information in this table is from references (138) and (137).

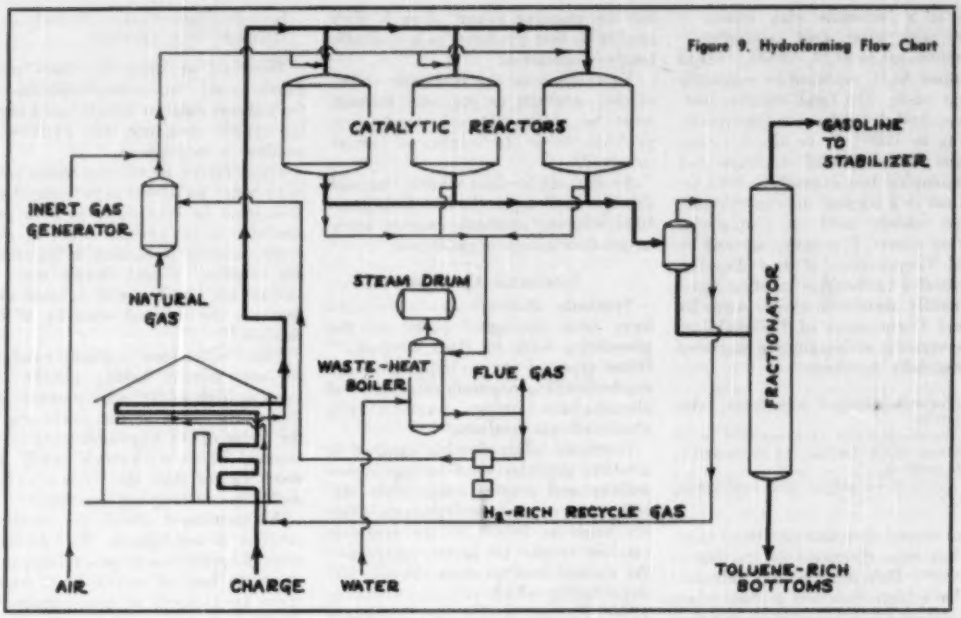


Figure 9. Hydroforming Flow Chart

catalytic treating with silica-alumina catalyst:

1) No desirable isomerization reactions take place.
2) Hydrocarbon loss occurs to polymeric tars.
3) Sulfuric acid is consumed.

Polytreating is the name applied to liquid-phase treatment with solid phosphoric acid UOP polymerization catalyst. Olefins are removed to form high-boiling polymers which can be recracked catalytically.

Hydrogenation may also be employed for the finishing of gasolines made by catalytic cracking.

Cracking Catalysts, Their Composition, Properties, and Manufacture

One of the ultimate aims of the chemical engineer is to be able to sit down and calculate what catalyst to employ to effect a given reaction in a desired manner. Some work has been done toward this end but much more remains to be done before this goal is achieved. However, recent work at Princeton University[138] has led to some interesting conclusions as to the choice of catalysts for hydrocarbon conversion. Work done with the aid of radioactive tracer elements showed that hydrogen transfer is the important reaction in most hydrocarbon conversion reactions and that the requirements of that reaction are satisfied by several compounds currently used in petroleum processing. Silicic acid and aluminum chloride are two compounds used as cracking catalysts which satisfy these theoretical considerations.

Hansford[139] has postulated a mechanism of catalytic cracking for reactions carried out in the presence of silica-alumina catalysts. Development and evaluation of mechanisms such as this are needed for intelligent choice and use of cracking catalysts.

As far as the choice available to the petroleum refiner today, there are two major types: natural and synthetic. Their comparative merits have been the subject of much discussion.[4] Basically, however, whatever their source, they are metal oxide catalysts. The effects of specific metal oxides on specific hydrocarbons have been surveyed by Egloff.[140] Cracking and reforming catalysts have been discussed, particularly from the standpoint of the patent literature, by Foster.[141] He points out that the method of preparation is critical and hence is covered by innumerable patents. Elkins et al.[142] have presented data covering this point for silica-alumina catalysts.

A yardstick for the determination of the effectiveness of any given material as a cracking catalyst is obviously needed. One such method has been presented by workers at Houdry Process Corporation[62] and another by workers in the Esso Laboratories.[143]

In the material to follow, aluminum chloride will be discussed briefly because of the historic interest attached to the McAfee process. Natural and synthetic catalysts in current use in Houdry, Thermofor, and Fluid units will then be treated in somewhat more detail.

Aluminum Chloride

Anhydrous aluminum chloride catalyst was first used in cracking by A. M. McAfee in 1913-1915.

In early manufacture, bauxite was briquetted with coking coal and heavy oil. After heating to 1500° F. these briquettes were charged into a vertical chlorinating furnace. Chlorine was passed downward for 8-10 hours at 1600° F.[144] Vaporized aluminum chloride passed downward from the bottom of the furnace to a firebrick cooler where it was deposited as a powder.

Modern developments in manufacture[145, 146] have resulted in a process in which powdered bauxite and coke are blown into a furnace chamber in a stream of chlorine. The aluminum chloride sublimes as it is formed and passes to a condensing chamber where it is recovered in anhydrous form.

Clay Catalysts

Some catalytic cracking occurred incidental to clay treating prior to active development of the art of catalytic cracking with clay catalysts.

Bentonite clays form active catalysts after acid treatment. Montmoril-

lonite is a bentonite clay which is widely used after acid treatment.[135] Its composition is $Al_2O_3 \cdot 4SiO_2 \cdot xH_2O$ with some Al_2O_3 replaced by magnesia or iron oxide. The fresh catalyst possesses a well-defined crystal structure. Heating to 1200° F. or above causes changes in the crystal structure and accompanying loss in catalytic activity.

Filtrol is a natural montmorillonite catalyst widely used in commercial cracking plants. It is manufactured by Filtrol Corporation of Los Angeles.

Porocel is a bauxite catalyst (predominantly aluminum oxide) made by Porocel Corporation of Philadelphia. Three varieties of bauxite are marketed commercially by them:

a) Porocel—catalyst, adsorbent, catalyst carrier.
b) Isocel—bauxite impregnated with anhydrous $AlCl_3$ for use as an isomerization catalyst.
c) Cyclocel—cracking and cyclization catalyst.

The crystal structure of Filtrol catalyst has been discussed in the literature.[147, 148] Dehydration and rehydration have been discussed as they relate to structure.[148] It has been found that processing of sour stocks of natural catalyst resulted in dehydration and consequent loss in catalyst activity. Controlled rehydration may be employed to permit processing of such stocks.

The surface area of the Filtrols averages about 300 square meters per gram as measured by the low-temperature nitrogen adsorption method. Such a material is a good cracking catalyst. Upon heating such a material to 1400° F., however, the surface area drops to about 10 square meters per gram and all cracking activity is gone.[147]

Florigel is a variety of Florida fuller's earth or floridin which can be kneaded with water to form plastic masses or creamy suspensions.[149] It may be incorporated into catalysts as a binder and is mechanically strong and temperature stable.

The cost of natural catalyst is below $100 per ton[4] on a dry basis, delivered. Natural catalyst thus has an advantage over synthetic catalysts, which are marketed at $300 to $600 per ton.

However carbon production in cracking is higher with natural than with synthetic catalysts, the ratio being 1.1:1 or higher. Makeup rates for clay catalysts, from the standpoint of combined maintenance of activity and replacement of losses, are also higher than for synthetic catalysts. Clay catalysts make 1-2 percent more motor gasoline with a corresponding decrease in C_4 products over synthetic catalysts but the gasoline is not of such high quality as that produced in a synthetic catalyst operation.

To summarize the economic status of clay catalysts, an economic balance must be made for each application problem due to the number of factors involved.[4]

As regards product quality, natural catalyst tends to produce olefinic gasolines whereas synthetic catalyst tends to produce aromatic gasolines.

Synthetic Catalysts

Synthetic silica-alumina catalysts have been developed based on the pioneering work of Hans Tropsch.[128] Other types of major importance are synthetic silica-magnesia catalysts, and alumina-base catalysts, particularly alumina-boria catalysts.[147]

Synthetic silica-alumina catalyst is a white, granular solid having higher activity and greater temperature stability than natural clay catalysts. After six hours at 1650° F., the synthetic catalyst retains 50 percent activity—the natural catalyst none. During 300 days during which regeneration at 1300° F. was carried out 12 times a day, more than 300 gallons of gasoline were produced per pound of catalyst.[135]

American Cyanamid and Chemical Company manufactures synthetic Fluid catalyst under the trade name of "Aerocat."

The Davison Chemical Corporation of Baltimore manufactures gel type Fluid cracking catalysts. Their 3-A catalyst was widely used in wartime aviation gasoline plants and continues to find wide application. Its use in the Suspensoid process has been tried and the results have been described by Burk[150] and by Caesar.[150A]

Fundamental principles regarding synthetic silica-alumina catalysts have been advanced as follows:[135]

1) Silica and alumina should be prepared in an hydrated form by precipitation or gel formation.
2) The hydrated silica and hydrated alumina can be precipitated either together, or separately, followed by blending.
3) The finished catalyst should be substantially free from solid metal compounds.

Because the catalyst was ordinarily prepared from water glass (sodium or potassium silicates), special washing methods were developed to purify the catalysts to the proper extent, since the presence of alkali metals is deleterious to stability.

Three types of synthetic catalyst were developed during the war by Universal Oil Products Company and manufactured by American Cyanamid:

Type A—Silica-Alumina.
Type B—Silica-Alumina-Zirconia.
Type C—Silica-Magnesia.

The first of these has been most widely used. In contradistinction to the natural catalyst which has a regular crystal structure, the synthetic product is amorphous.

Impurities in silica-alumina catalysts must be carefully controlled. Iron must be held down to 0.05 percent due to its adverse effect in promoting carbon formation in the cracking reaction. Alkali metals such as sodium are not desirable because they decrease the thermal stability of the catalyst.[152]

These silica-base cracking catalysts are very porous, having specific surfaces as high as 600 square meters per gram. The sizes of the pores are of the order of 50 Angstrom units in diameter, which although small, are much larger than the hydrocarbon molecules undergoing reaction.

As mentioned above, the synthetic catalyst is amorphous. The development of crystalline phases accompanies complete loss of activity and results from treatment at temperatures of 2000° F. Specific surface and activity are greatly reduced after calcining at 1800° F.

As previously mentioned, UOP has also developed a silica-magnesia cracking catalyst. This catalyst has the same basic advantage over natural catalyst that the silica-alumina catalyst possesses, namely—controlled composition and reproducible physical properties.[11] This type gives substantially higher gasoline yield than silica-alumina catalysts but the gasoline has a lower octane rating. These two synthetic catalyst compositions bracket natural clay catalysts as regards yield of gasoline and octane number but both synthetic catalysts have the advantages of lower coke production and lower replacement rate. The silica-magnesia catalyst will not tolerate heating above 1400° F. and in this respect resembles natural clay catalyst.

All of the catalysts described up to this point have been silica-base catalysts. Alumina-base cracking catalysts have been the subject of much recent work by various development organizations in the petroleum industry, however. One type contains boron oxide, or boria, supported on the alumina. The surface area of this type of catalyst is less than that of the silica-base catalysts, running about 150-200 square meter per gram with an average pore diameter of 100-120 Angstrom units—higher than for the silica-base materials.[147] In thermal stability, these new alumina-base types are equal to the silica-magnesia and natural catalysts.

An undesirable feature of catalysts

containing boric oxide is the loss of boron in the form of boric acid which results from the hydration of the catalyst by steam. Thus process or regeneration gases containing steam will continuously remove active catalytic material which must be replaced. Improved stability of this type of catalyst may be gained by the incorporation of a small percentage of an alkali metal.[152]

A final chemical variety of synthetic cracking catalyst which should be considered here is the molybdenum catalyst used in the hydroforming operation previously described in this paper. Two recent summary articles cover fundamentals of hydrocarbon reactions over these catalysts and give details of catalyst preparation.[153, 153A]

The actual manufacture of various synthetic catalysts, particularly in the new spherical forms, is an art in itself. A pellet dryer was specially developed[154] for the drying of catalyst pellets for use in the Thermofor cracking process. In the section on Thermofor cracking, several patents pertaining to the specific process of making catalyst beads were cited.[67, 68, 69, 70, 71, 72] One of the first patents on this type of catalyst was issued to the Philadelphia Quartz Company.[155] The manufacture of the small spherical or "microspheroidal" catalyst particles used in Fluid cracking has also been described in a recent patent.[156]

Laboratory Work on Catalytic Cracking

The functions of the refinery laboratory, for the purposes of this discussion, may be divided into process development work and plant control work. We will first consider process development work.

Pilot-plant work on Fluid catalytic cracking has been described in a vareity of references.[157, 158, 159, 160] Table 5 summarizes some of the characteristics of several of these plants and it is interesting to compare these figures with figures given for a large plant unit which these small units "pilot" on the way to better yields of better products.

These small units are commonly built of stainless steel to prevent any corrosion problems although carbon steel has proven superior from the standpoint of erosion in commercial units. Nitrogen is commonly used for catalyst stripping instead of steam, and for instrument purge lines in place of inert gas, steam, or hydrocarbon gas. All lines are heavily insulated and in addition, each section of line is provided with an individual electric resistance heater to hold thermal losses to a minimum. Cyclones, which are universally used for catalyst recovery in commercial units, are commonly

TABLE 5

PLANT	Feed, Bbl. Day	Reactor	Regenerator	Standpipes
Cities Service[160]	2	6" x 24'	8" x 18'	
Humble[158]	6	4" x 35'	6" x 24'	1¼"
Esso Pilot[82]	2	2" x 20'	4" x 20'	1½" x 40'
Esso Suez-Werke[87]	100	12" x 31'	22" x 31'	4"
Large commercial unit for comparison[76]	12500	23' x 50'	40' x 50'	30"

replaced by porous Aloxite filters in these pilot units. The filters are used alternately with a blow-back period to prevent plugging and excessive pressure drop at this point. Process steam for one of these small units may be generated by vaporization of a controlled feed of distilled water in a special steam generator.[160]

The wider use of pilot plants in the modern refinery has been discussed by The M. W. Kellogg Company engineers.[161]

Fixed-bed catalytic cracking pilot units used by Union Oil Company of California have been described by Bradley.[162] These units are designed for adiabatic operation. Two reactors are provided so that reaction and regeneration operations may be carried on simultaneously, each reactor being constructed of stainless-steel tubing 2¼ inches o.d. with 1/16-inch walls, 16 feet long. There are six individually controlled electric heating coils per reactor. These units were designed to be versatile and may be used for the study of any fixed-bed cracking operation. Results indicating the degree of channeling in a catalytic bed have been reported recently as a result of work done on this unit.[163]

Other work reported recently is that done on reactor design[164] for the hydroforming operation conducted by Standard Oil Company of California, previously described.

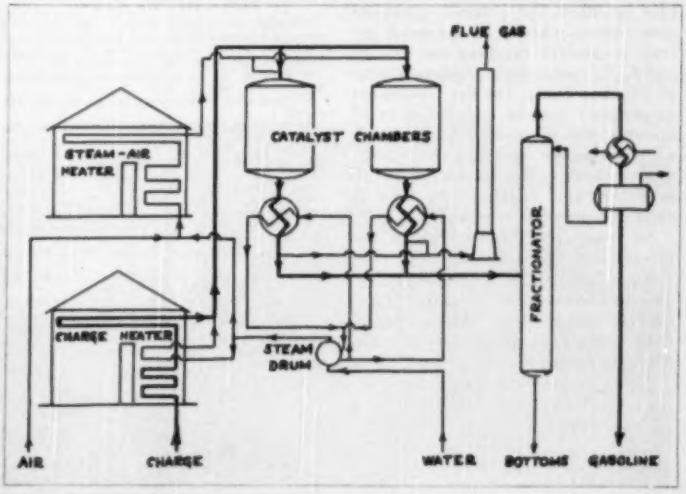
Analysis of complex hydrocarbon mixtures, study of catalyst structure and composition, and determination of catalyst activity are functions of the refinery laboratory. Although these are not control work in the routine sense, they all contribute to the effective control of the unified cracking process in the plant.

The complex hydrocarbon gas mixtures encountered as feed and product in catalytic cracking plants are best analyzed by newly developed techniques.[165]

One of these techniques is infra-red analysis.[166] The infra-red absorption spectrum of an organic molecule is unique and with few exceptions admixture with other compounds does not affect this property. As a result the concentration of any component in a sample can be determined by infra-red analysis, provided it has at least one absorption band at a wave length where the other components are relatively transparent. In the case of butadiene analysis for instance, the gravimetric maleic anhydride procedure requires from 5-6 hours as compared to the 10 minutes needed to make duplicate infra-red determinations. A description of the application of infra-red analysis to alkylates[167] will serve very well to illustrate the application of the method.

Mass spectrometry is another method

Figure 10. Fixed Bed Process



used for routine analysis of complex hydrocarbon mixtures.[168,169,170] Essentially this method consists of determination of the composition of a mixture from its mass spectrum and a knowledge of the mass spectra of the components in that mixture. The mass spectrum of a pure substance may be defined as a plot of the relative abundances of positive ions formed at different masses when the substance is bombarded with electrons. The mass spectrum of a substance is found to depend on its molecular structure as well as on the number and kinds of atoms forming the molecules. Generally speaking then, there is a one-to-one correspondence between the mass spectrum of a substance and that substance. This characteristic permits the quantitative analysis of a mixture from its mass spectrum even though some of the components of the mixture are isomers.

Only a few cubic centimeters of the gas to be analyzed are required in mass spectrometry. The gas is first ionized. Then the ions are shot into a magnetic field that deflects them so that only the ions for which the controls are set will pass through an exit slot to impinge on a collector plate where their charge is given up for measurement by a galvanometer or by means of graphic recorder. Varying the controls projects different ions through the exit slit progressively, thus grading the molecular components of the gas.[171]

Since each peak in the mass spectrum of a mixture is a sum of contributions from its components, analysis of the mixture may be made from its mass spectrum by solving a set of simultaneous equations. This is done with the aid of calculating machines.

Accuracy of such an instrument is plus or minus 0.5 percent. Complete quantitative analysis of overhead gas from a catalytic cracking unit for H_2 and C_1-C_3 components requires a total of 2¾ man hours. The key component (n-pentane) may be determined in 45 minutes. For common mixtures such as depropanizer overhead or bottoms, computation time is less than 10 minutes and instrument time is approximately 20 minutes.

So much for the analysis of the process streams.

X-ray diffraction is the analytical tool used in the study of catalyst structure and composition.[172] Phase changes from gamma to alpha alumina and crystal growth, two processes which, when combined, will destroy catalyst activity, may be studied. Overheating may be eliminated by a process study of these variables by x-ray diffraction. Amorphous and crystalline catalysts may be studied leading to the development of new catalysts with improved activity and stability.

Spectrographic methods may be used in catalyst analysis.[173] These methods are specially useful in the determination of metallic elements in low concentrations where the accuracy of the method exceeds that of other analytical methods. If a large number of analyses are to be made, spectrographic methods are also time-saving. Quantitative accuracy will not exceed 10 percent of the amount of the element present. For example if a clay catalyst contained 10 percent magnesium, only plus or minus 1 percent could be expected. But if 0.01 percent magnesium were present, it could be reported as plus or minus 0.001 percent.

Determination of specific surface and particle size of catalysts have been described by a series of authors.[142,174,175] Nitrogen adsorption methods are commonly applied to the determination of surface area.

The determination of carbon in catalyst deposits with an eye to regulation of reaction and regeneration conditions is of obvious importance. A method of determination for fixed-bed catalysts which are to be regenerated in situ has been described.[176] The outlet gas stream is sampled and the CO therein oxidized to CO_2 which is absorbed in Ascarite.

Simple miscroscopic examination of catalysts combined with photomicrography is very informative.

End of Part IV and series.

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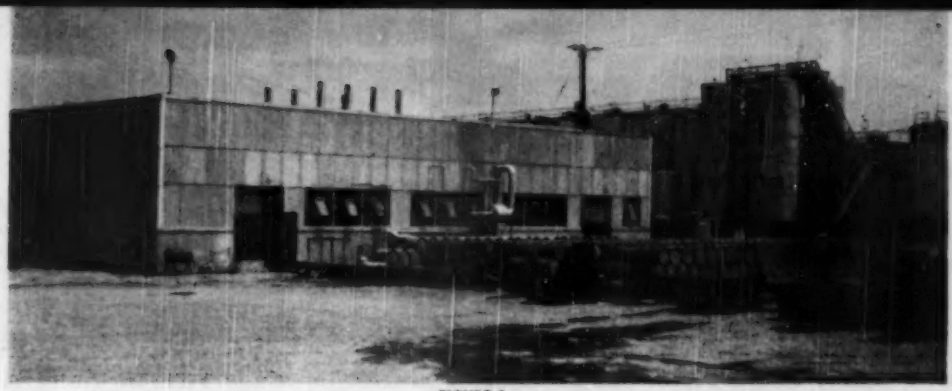


FIGURE 1

New Oil Drums Made from Old Ones

FIGURE 2

UNION Oil Company of California has put into operation at Oleum, Calif., a new plant, **Photo 1,** for reconditioning barrels that are used in shipment of refinery products. The plant has a capacity of 800 55-gallons each eight-hour shift. Lightweight drums, made of 18 gauge metal, have a life expectancy of four or five round trips to the customer and return; galvanized drums with heavy steel hoops stay in service as long as 10 years but their heavier weight eats up lots of freight charges.

Photo 2. A power-driven conveyor moves returned drums from the truck-unloading dock to stacks where the barrels are stored to await reconditioning. Here they are segregated into ricks according to their condition. Those facing major overhauls are worked up in slack periods when more time can be given them.

One long conveyor operates beside the stacks with spurs leading between ricks. Drums scheduled for cleaning are brought into the plant and follow a "production line," the first step being a decontaminator where, by means of steam and hot water, all oil and foreign material are loosened and siphoned from the barrel.

Photo 3. Air-operated, hydraulic de-denting machines then receive the barrels and remove the dents out of both the sides and heads. This unit consists of two presses operated by compressed air. After the dents are removed the barrel passes on and the chime is restored to its original contour. **(Photo 4.)** The chimer consists of a flat plate about the size of the drum head and a movable ring that presses against the outside of the chime while the drum is revolved by the rotating plate.

Next comes the welding station where

FIGURE 3

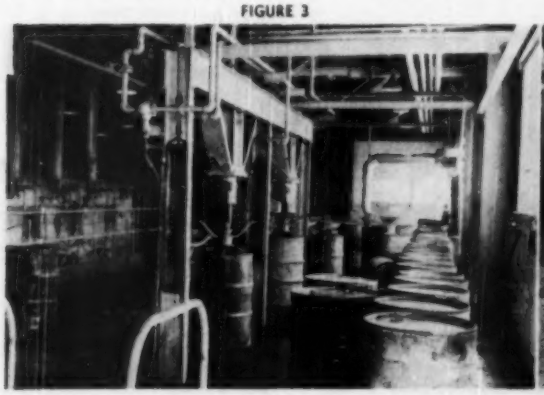


FIGURE 4

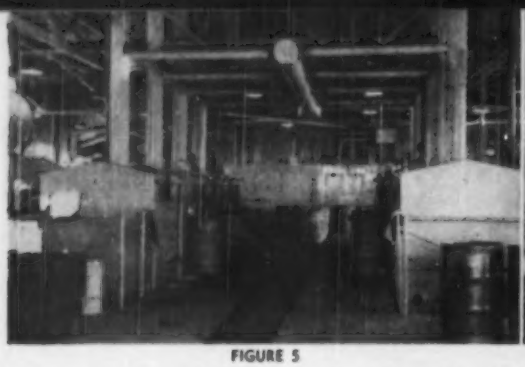


FIGURE 5

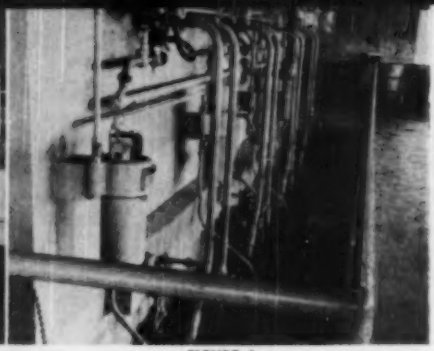


FIGURE 6

small punctures are repaired, bung flanges replaced and other damage remedied. Then the drums are passed to the cleaning units **(Photo 5)** where exterior paint is stripped off and any foreign matter left by the decontaminator is removed. These two units, built opposite each other, handle eight barrels simultaneously. A wash solution is pumped into the drum while a spray is driven against the exterior. Five minutes is required for the operation including two minutes for drying with air at 25 psi. and 250° F. Automatic equipment that controls the cleaning cycle is shown **(Photo 6)** at the back of a unit.

Careful inspection of the interior follows and, if needed, the drum goes to the chainer where five six-foot length of chains made of hard metal with angular links and sharp corners are inserted and the drum shaken and rotated 15 minutes. This removes all rust.

Photo 7 shows the machine where the drums are given an automatic "shine" by steel brushes revolving against the exterior for 20 minutes. Then they are automatically ejected onto a conveyor leading to the drying tunnel, **Photo 8.** Here the drum moves along 6 to 12 feet per minute between rows of infrared lamps that dry the exterior of the drum and thus prepare it for painting.

The dry drum is ejected from the tunnel onto a chute that leads into the air-conditioned paint booth **(Photo 9)** where the table is placed waist high and the operator handles two spray guns simultaneously, one handling orange paint for the heads and the other a deep blue for the body.

The final step is the paint-drying tunnel **(Photo 10)** where the enamel is baked on at a temperature of 200° F., also with infrared lamps. The drums go along on conical rollers that touch only the edges of the chime. When dried, the drum is automatically upended to another conveyor leading to the compounding room. Here the drum with its new look is ready to be filled with oils for shipment.

FIGURE 7

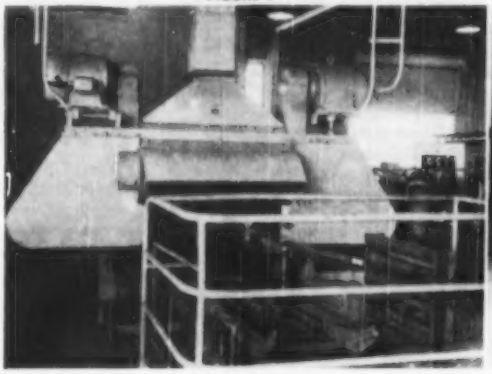


FIGURE 8

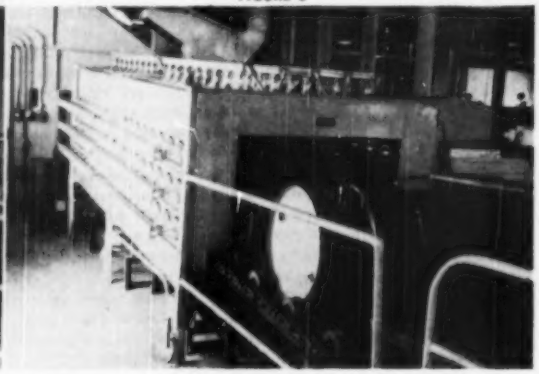


FIGURE 9

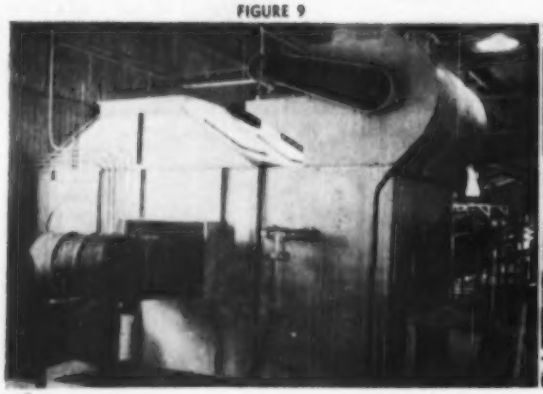


FIGURE 10

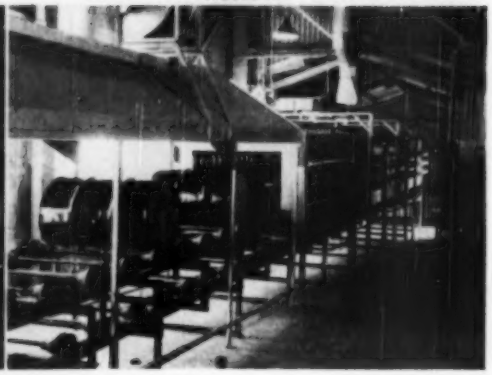
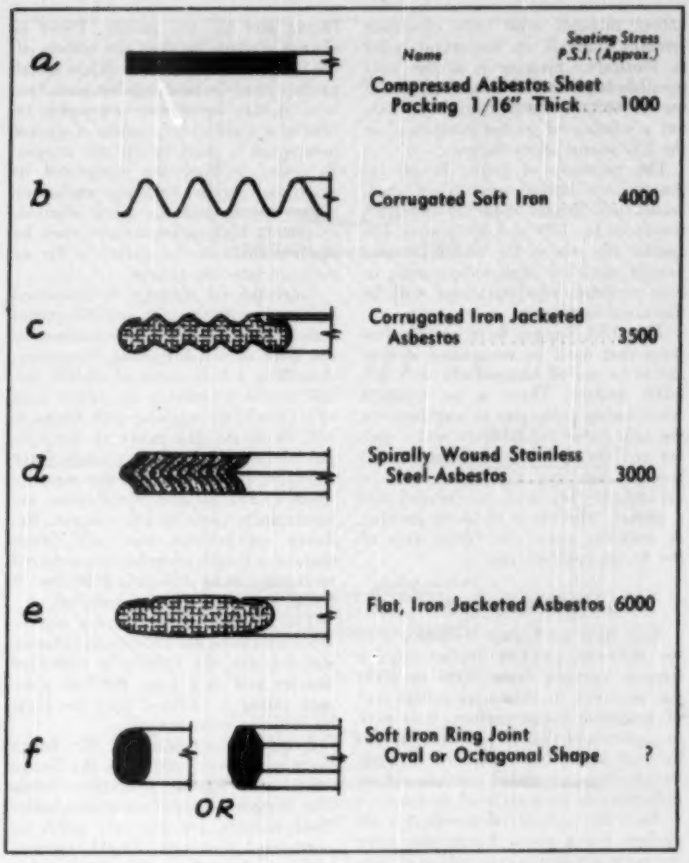


Figure 1
Popular Oil Industry Gaskets



THE OIL industry has been the most important factor responsible for the development and growth of the metallic gasket industry. This was one of the first to require the use of innumerable joints that could be easily disassembled in lines and vessels handling a wide range of pressures and temperatures. In the last few years, the pressure limits have been extended to include a range from a full vacuum to thirty thousand psi., and the temperature limits range from 320° F. below zero to nearly 2000° F.

This discussion was presented at the Petroleum Mechanical Engineering Conference, New Orleans, September 27, of the American Society of Mechanical Engineers.

Metallic Gaskets Given Boost By Oil Industry Development

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IN SPITE of the range of temperatures and pressures that must be held and the wide variation in the equipment to be sealed, relatively few of the available materials and styles of gaskets are in general usage in the oil industry. Any discussion of gaskets can be confined to the six basic styles shown in Figure 1. The merits and limitations of each of these gaskets will be outlined and various features of installation technique or closure design that may have an effect upon their performance will be pointed out.

Non-metallic gaskets such as those cut from sheet packing and similar relatively soft materials may be readily seated or sealed in the flanged joints normally used throughout the oil industry. However, metallic gaskets, being fabricated from hard materials, are much more difficult to seal, and a brief review of the problems of gasket design will help to explain the relative merits and limitations of the different types.

In Figure 1 are shown the number of pounds that must be applied to each square inch of gasket area in order to initially seat the different styles of gaskets. These gasket stresses are only approximate but indicate the relative ease or difficulty to be expected in initially molding the gaskets to flange contact faces that have been provided with a smooth machined surface finish. The values would be many times higher for rough facings and somewhat lower for ground and lapped facings. The use of a gasket compound also lowers the values considerably.

A Perfect Joint

A perfect joint is one in which all clearance between the gasket and contact faces has been reduced to zero, and no confined fluid or gas can escape, except by diffusion through the material itself. This perfection is seldom reached in commercial practice, an adequate seal being obtained when the clearance has been reduced sufficiently to prevent leakage of the particular fluid or gas at the pressures in-

volved through what little clearance remains. This is an important point to remember because it is the only possible explanation for the successful use of certain metallic gaskets without a coating of gasket compound in the 150-pound series flanges.

The majority of joints in oil industry installations are forged steel, raised-face flanges made to the ASA standards for 150- and 300-pound. The special features of the ring type joint flanges used for high temperature or high-pressure applications will be discussed further on.

The ASA flanges have certain features that must be recognized if they are to be sealed successfully with metallic gaskets. There is no constant relationship from size to size between the bolt force available to seat a gasket and the area of the flange contact face. It has been the practice of the oil industry for years to demand that a gasket, whether it be sheet packing or metallic, cover the entire area of the flange contact face.

Varying Stresses

Reference to Figure 1 shows that the different gasket styles require stresses varying from 1000 to 6000 psi. in order to obtain an initial seal on a smooth flange surface. It is easy to understand that if bolt stresses are held at a constant value in a given flange size, the gasket size should be different for each style of gasket.

Since the industry demands that all gaskets for a given flange size have the same dimensions regardless of material, obviously the bolt force applied must be higher for one type than for another, if the same degree of seal is to be obtained.

Furthermore, it is the exception rather than the rule of the industry to use flanges with smooth machined faces for general service. The standard surface finish appears to be the "phonographic" type or a modification of it. This facing consists of a relatively deep groove either "V" or "U" shaped that runs in a spiral from the bore of the flange to the outer edge of the raised face. Originally developed to provide radial reinforcement for soft, non-metallic gasket materials, it is still being furnished by many flange manufacturers as the standard facing for all purposes.

The phonograph type of facing is not difficult to seal with non-metallic gaskets, although it is easily demonstrated that such a facing actually requires a higher initial gasket stress than a fine tool machined finish. However, the common gasket metals cannot be compressed with sufficient pressure to force them into a phonographic facing and fill the groove. There is always a space between the bottom of the groove and the gasket. When metal gaskets must be used against such facings, it may be almost impossible to obtain a tight joint, unless a gasket compound is used to fill the groove. In order to hold the compound in place and prevent its being washed or blown out through the spiral channel, extremely high gasket stresses must be applied to force the gasket as far as possible into the groove.

Since the oil industry is concerned primarily with the 150- and 300-pound series flanges, let them be examined in the light of the foregoing discussion. Assuming a bolt stress of 20,000 psi. and a gasket covering the entire area of a raised-face welding-neck flange, it will be found that many of the 150-pound sizes do not have enough force available to seal any of the metallic gaskets. The 3- and 8-inch sizes are particularly poor in this respect. Refinery maintenance men will admit that extra length wrenches are required to tighten most 150-pound flanges if metal gaskets are being installed.

The 300-pound flanges are not as troublesome as the 150-pound because, size for size, the bolting is somewhat heavier and only when the full pressure rating is utilized must the bolts be initially overstressed.

Initial overstressing of the flange bolts to two or three times the design stress will do no particular harm. The flanges will dish somewhat under these stresses, but generaly suffer no permanent damage. Furthermore, within a short time after the line has gone into operation, particularly if the temperature is high, the bolts, flanges and gasket will "relax," the total effect of which is generally an over-all reduction in stress to values close to the design limits. There are, of course, certain combinations of conditions that will prohibit the application of bolt stresses much above the design limit, but these are exceptional in general refinery operation.

Avoiding Overstress

Initial overstressing of bolts and flanges can be avoided by modifying gasket dimensions. This is most easily done by increasing the inside diameter of the gasket to the point where the gasket area is such that it can be sealed with lower bolt stresses. This reduction in the width of some metallic gaskets dimensioned for standard flanges has become imperative for another reason.

Today more and more refineries and gasoline plants are using slip-on flanges where previously welding-neck or lapped-joint were installed. The flexibility of design and smaller fitting inventories, plus ease of fabrication, have increased the use of slip-on flanges to the point where they now greatly outnumber the other types for general piping work.

The gasket contact face of a slip-on flange is narrower than the face of a welding-neck flange, the difference amounting to the wall thickness of the pipe. In the smaller sizes of the 150- and 300-pound flanges, this difference in contact face width results in a high percentage reduction in gasket area, enough so that in many instances the need for overstressing of the bolts may be almost entirely eliminated.

However, the use of these slip-on flanges presents a problem to the users of gaskets such as are shown in Figure 1 as *c*, *d*, and *e*. With these gaskets, the primary seal is provided by the compression of the inner lapped-over edges of styles *c* and *e*, or the inner metal-to-metal plies of style *d*. If this inner edge is not firmly compressed, these gaskets will leak.

Welding-Neck Flanges

With the exception of the spirally-wound type (Style *d*), all the gaskets, including the sheet packing type, are listed in the catalogs of most gasket manufacturers in dimensions suitable only for welding-neck flanges. For example, the listed standard size for a 3-inch, 150-pound sheet packing gasket is 3 inches x 5⅜ inches and the standard sizes for styles *b*, *c*, and *e* is generally shown as 3¼ inches x 5¼ inches with some minor differences between manufacturers and styles. The bore of a 3-inch, 150-pound welding-neck flange is 3-1/16 inches, whereas the bore of a 3-inch, 150-pound slip-on flange is 3-9/16 inches.

Gaskets of styles *c* and *e* dimensioned with a 3¼-inch inside diameter will not be compressed around the inner edge and will leak when used between flanges one of which is of the slip-on type. Gaskets of the styles *a* and *b* may not leak, but the unsupported portion of the gasket will project into the line causing turbulence with subsequent acceleration in the rate of corrosion or erosion, accompanied by the possibility that part of the gasket may break away and clog a valve or damage the equipment.

Plants using metal-jacketed asbestos gaskets in slip-on flanges should be certain that they have large inside diameter gaskets available for installation in such flanges. If the majority of lines have slip-on, only the large inside diameter gaskets should be carried in inventory, to avoid confusion. The

large i.d. gasket will seal more easily and can, of course, be used in welding-neck flanges.

The spirally-wound gasket (style *d*) has always been dimensioned for use in slip-on flanges and only when ordered for special flanges must precautions be taken to select the proper dimensions.

Compressed Asbestos Sheet Packing Gaskets

The gasket shown as Figure 1 *a* represents the material used almost universally throughout the oil industry from the time the oil comes from the well until the finished product is shipped to the consumer. Known to the trade as compressed asbestos sheet or "sheet packing," this material is essentially asbestos fiber bonded with a small percentage of rubber compound. Because the material is relatively soft, the standard 1/16-inch thick gasket can be sealed without excessive overstressing bolts or flanges, even though the flange facings may be in poor condition.

Sheet packing gaskets can be used throughout a wide range of temperature and pressure conditions, and the general purpose sheet will resist reasonably well the deteriorating attack by most oils and oil products, even though not specially compounded for resistance to these materials.

The limitations of sheet packing gaskets are dependent upon the relationship of the operating temperature to the pressure. Sheet packing can be used to seal almost unlimited pressures at room temperature, if the closure is designed to give sufficient reinforcement and the gasket is thin. However, asbestos fiber loses its strength and turns to powder at temperatures much over 700° F., at a rate that depends upon the temperature. At 1300° F. the change is almost instantaneous. When combined with rubber as a binder, the loss of strength is not appreciable at temperatures below about 900° F., and sheet packing gaskets may be used without trouble for low pressures at temperatures up to 850° F. Over 850° F., it must be remembered that the sheet packing will have little strength or ability to seal in flanges subject to bending or vibration, and pressures much above 50 psi. may cause leakage.

The following rule-of-thumb may be applied as a guide in determining whether a sheet packing gasket or a metallic gasket should be used in a given installation: "If the product found by multiplying the operating pressure (psi.) by the operating temperature (°F.) does not exceed 250,000, sheet packing gaskets may be used. The rule should not be applied when pressures exceed 1200 psi. or temperatures are over 850° F. Sheet packing gaskets may be used at higher pressures, and perhaps, at higher temperatures, but complete data on the installation should be carefully considered before making the selection."

The limits defined by this rule-of-thumb will be found to be those in use in most refineries for gaskets in lines handling water, steam, hot oil, gas and oil products. The packing used is the standard general-purpose material in the 1/16-inch thickness. The flanges are standard ASA 150- and 300-pound raised-face, with either smooth machined or phonographic facings. The same material is also used in the majority of heat exchangers and process vessel flanges. In such equipment, however, the limits may be somewhat lower, if the gasket width is less than ½ inch.

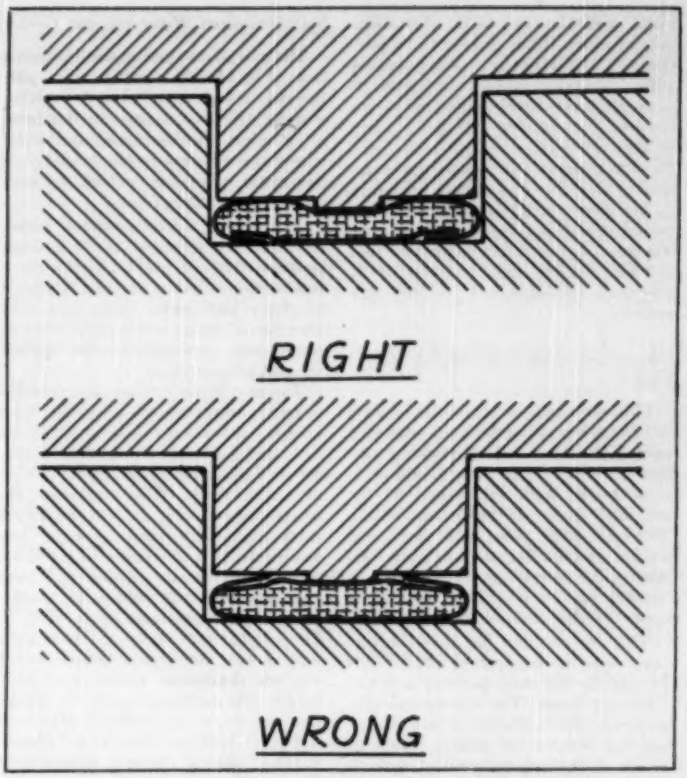


Figure 2. Proper position to install Metal Jacketed Asbestos Gasket in Joint with raised nubbin on one face.

Corrugated Metal Gaskets

The corrugated metal gasket shown as style *b* in Figure 1 was at one time the most popular style for refinery use where sheet packing was not satisfactory. The standard gasket is fabricated from .019-inch thick soft iron sheet and corrugated with a ¼-inch pitch. The corrugations are concentric.

When compressed between flanges, the corrugated gasket is flattened out and becomes in effect a wrinkled flat washer with no resilience or ability to compensate for flange movement. Because the gasket will compress close to the original metal thickness, the flange faces must be brought up parallel. Users of this corrugated gasket have reported cases of flange and bolt breakage during installation occasioned by attempts to overcome cocked and misaligned flanges.

Unless coated with a gasket compound before installation, it is almost impossible to seat the plain corrugated gasket in 150-pound flanges without stressing the bolts several times over the design stress. In refinery service, this gasket is seldom used without a coating of gasket compound and today generally is not used for pressures much above 50 psi.

This single thickness corrugated

metal gasket has two fields of application in which it has proven to be particularly satisfactory. When coated with a suitable gasket compound, it is widely used to seal high-temperature low-pressure (under 100 psi.) gases in lightly-bolted flanges. Also, for Dowtherm service it is standard practice to use the corrugated soft iron gasket coated with compound in 300-pound raised-face flanges. In these instances, it is the gasket compound that provides the seal, and the gasket itself acts as a reinforcement for the compound.

Corrugated Metal-jacketed Asbestos Gaskets

This construction shown as style *c* in Figure 1 is today the most generally used alternate for sheet packing gaskets in refinery pipe flanges and pressure vessels. With few exceptions, the standard gasket is made up with a .019-inch thick soft iron shell and washer and a filler of high purity asbestos. The overall gasket thickness is usually 1/8- or 5/32-inch, depending upon the thickness of the filler used.

This construction has many advantages over the corrugated metal (style *b*) and the flat metal-jacketed asbestos (style *e*) types. The corrugated construction allows the use of a wide gasket, but lowers the sealing stress by virtue of the reduced contact area. If fabricated with deep narrow-pitch corrugations and assembled as shown in Figure 1 with the corrugations nesting, the gasket will not flatten out when compressed and will have sufficient resilience to maintain a seal in joints subject to considerable movement. The concentric corrugations act as labyrinth seals, should slight leakage take place across the inner edge, whereas the flat metal-jacketed asbestos gasket (style *e*) offers no barrier to leakage, except at the inner and outer edges.

Because of its initial thickness and its relatively soft construction, the corrugated metal-jacketed asbestos gasket can compensate for some out-or-parallelism and misalignment of flanges.

When used in 150- and 300-pound flanges, the corrugated metal-jacketed asbestos gasket will seal at lower bolt stresses than the plain corrugated metal or flat metal-jacketed asbestos gaskets. If the flanges are rough or have a phonographic finish, the gasket should be given a light coating of a gasket compound when installed.

Where failures of this type of gasket have been experienced, they can generally be traced to the use of dimensions that were not correct for the flanges involved.

Spirally-wound Metal-asbestos Gasket

The spirally-wound gasket shown as style *d* in Figure 1 consists of a preformed metal strip wound together with a strip of asbestos in the form of a spiral. At the inner and outer edges, the asbestos is eliminated, and the metal plies are welded to each other to lock the gasket.

As yet, the spirally-wound gasket has not been accepted as the general purpose refinery gasket, except in a few locations. Its use has been confined to steam and water lines, probably because of unfavorable experience some years ago with its use against oil and oil products.

Those refineries using the spirally wound gasket for all purposes have found that there are some precautions that must be taken. The standard gasket as fabricated is approximately 3/16-inch thick. When installed between flanges with smooth machined faces and compressed more or less uniformly to a thickness of approximately 1/8-inch, the gasket will seal against almost any fluid at high pressures and temperatures up to 900° F. The construction of the gasket is such that it has the highest resilience of any metal-asbestos gasket, actually being able to compensate for flange separations of as much as .005 inch without leaking. Between "phonographic" flange facings, however, it has been found to be necessary to compress this gasket to thickness less than 1/8-inch, and a style of centering guide must be used that does not interfere with this extra compression. Installation technique must be controlled to assure uniformity of compression, otherwise the "phonographic" facing will not be sealed off at the inner edge of the gasket.

For service at pressures above 500 psi. or at temperatures above 500° F., it is generally accepted practice to make the spirally-wound gasket with stainless steel. Below these limits, soft steel is normally used if suitably resistant to the confined fluid.

Flat Metal-jacketed Asbestos Gasket

This flat metal-jacketed asbestos gasket, shown as style *e* in Figure 1 consists of a metal shell and washer formed to completely enclose a filler of high purity asbestos. Although a few refineries use these gaskets in pipe flanges as an alternate for sheet packing, this construction is more generally used to seal heat exchanges and other pressure vessels in which the gasket face is relatively narrow. For flange widths over 1/2-inch, the corrugated metal-jacketed asbestos gasket is preferred, but it is not practical to make the corrugated construction for narrower widths.

It was mentioned before that the flat metal-jacketed asbestos gasket seals only on the inner and outer edges where the metal shell laps over the filler and washer. It is therefore very important that these areas be carefully formed, when made, and firmly compressed when installed.

Several manufacturers of heat exchangers machine a raised nubbin 1/8-inch wide and 1/64-inch high in the contact face of one of the mating flanges. This nubbin may be used on a flat face or on the tongue of a tongue-and-groove joint. The purpose of the nubbin is to apply a localized high stress at the midline of the gasket face. When used with plain flat gaskets cut from service sheet or solid metal, the raised nubbin is a foolproof means of increasing gasket stresses. When used with metal-jacketed asbestos gaskets, however, leakage may occur because of the nubbin, unless the gasket is properly installed.

Figure 2 shows the correct position of installation of a metal-jacketed asbestos gasket in a joint, one face of which has been provided with a nubbin. The gasket must always be installed with the lapped edge side away from the nubbin or the tongue. If the lapped edges are placed against the nubbin face, the compressive load will be concentrated on the washer surface, and very little will be on the lapped edges. Leakage can and does take place under these conditions.

The quality of workmanship used in the fabrication of a metal-jacketed asbestos heat exchanger gasket can have considerable effect upon the efficiency of operation and maintenance costs of the equipment.

These gaskets are made in so many sizes and shapes and in such small quantities that they are essentially handmade items, subject, therefore, to the skill of individual workmen. Ring gaskets present no particular problem in fabricating free of wrinkles and cracks, but gaskets with ribs require more than average ability to make.

In making a metal-jacketed asbestos gasket with rib work, extreme care must be taken in drawing the metal at the intersections of rib and outer ring, or rib and rib, so that it will form a smooth lap of uniform width over the filler and washer. If the metal is overstressed in drawing, the metal lap will be split open, allowing a leak at that point. Drawing the metal too far will cause the formation of wrinkles or folds in the lap itself. If the metal lap at any place on the gasket is folded over on itself, the gasket is thicker at this point and cannot be

compressed in the surrounding areas. A cracked lap will allow slight leakage, but a fold will cause dangerous leakage. Instances have been reported of severe erosion of channel head baffles and serious losses in exchanger efficiency due to the use of ribbed gaskets that were poorly made and on which the metal laps were folded on themselves at the intersections of the ribs with the outer rings. Gaskets of this poor quality should be avoided, particularly if the equipment is handling slurries of an abrasive nature.

In certain cases, refineries have found it to be necessary to use equipment originally designed for sheet packing gaskets in service requiring metal gaskets. Unless the equipment was overdesigned when built, difficulties can be expected in attempting to seal the metal gasket. Resurfacing of the gasket contact faces to provide a smooth finish and drilling out the flanges to take the next larger size of bolt may solve the problem. In some cases, the gasket width can be reduced, but this generally poses a problem in location of the gasket during installation. The gasket can be held in place quite readily with strips of cellophane adhesive tape. These strips do not prevent a tight seal.

Ring Type Joint Gaskets

The ring type joint gasket (Figure 1 *f*) in either the oval or octagonal cross-section is used in all phases of the oil indutry for high pressure and for high temperature service. They can be used only in specially grooved flanges.

The oval shape is the more popular, probably due to the difference in cost, but for critical high pressure service, particularly against steam and gas, the octagonal shape has proven to be more satisfactory.

The oval ring made from soft iron is by far the most widely used form of ring joint gasket. It is used in most high pressure well-head equipment, in pipe line station manifolds, and in much refinery piping. Some gaskets made from a modified Type No. 502 alloy (4-6 percent chrome ½-percent Mo) are used for the more sour oils, and a few refineries are changing over to the various stainless alloys for severe corrosive service.

Most specifications call for the soft iron gaskets to have a hardness not exceeding 90 Brinell. The API, however, specifies (API Standard No. 6B) only that the gasket be softer than the flanges. This latter specification is not difficult to meet with soft iron or Type No. 502 alloy (modified) but may be impossible to comply with in the various stainless alloys.

In order to obtain maximum corrosion resistance in a stainless steel flange, it is generally necessary to heat treat the material to the dead soft condition and, therefore, the flange will have the same hardness as the stainless steel gasket.

Preventing Leakage

The soft iron oval gasket with a hardness of 90 Brinnell should be easily seated in a steel flange with a hardness not less than 140 Brinell. Nevertheless, we find that in many instances, in refinery flanges particularly, a joint using the oval ring must be very heavily bolted to prevent leakage; in fact, so heavily bolted that the flanges have dished to such an extent that only the outer edge of the gasket is providing the seal. And yet, theoretically, the oval shape should seal at very low unit stresses. The surface finish of the flange groove appears to be responsible for failures to obtain a seal with the oval ring at normal bolt stresses and is known to account for the failure of gaskets even of the octagonal shape to seal easily against high pressures. The tool marks on the surface of the tapered sides of the flange groove are exactly the same as a "phonograph" facing, but much finer. When the oval gasket is installed, there is at first only a thin line of contact with the groove face. This thin line is not wide enough, nor has the gasket been wedged in the groove sufficiently to seal off these spiral tool marks which can only be accomplished by smearing of the surface of the gasket or of the groove. In order to widen the line of contact and distort enough of the gasket to seal off these marks, the bolts must be heavily stressed. This high stress, in addition to dishing the flanges and taking the load off the inner edge of the gasket, may harden the surface of the gasket, causing it to dig into the groove surface. In such cases, the groove must be remachined before the joint can be reused.

Although the octagonal ring has a wider contact face when first installed, only a light bolt load causes wedging action over a wide area of tool marks, effectively sealing the joint. Because it is not necessary to stress the bolts so heavily, the flanges are not distorted or the grooves damaged, and the gasket maintains a seal on both edges. For high pressure steam, gases, Dowtherm, and the 10,000 psi. oil field flanges, the ring grooves are generally given a mirror finish and octagonal rings are used. These precautions are necessary if the joints are to be maintained at safe design bolt stresses.

In conclusion, it is worth noting that a gasketed joint is only as perfect as the mechanics in charge of the assembly. Carefully machined flanges and flawless gaskets will only perform to the satisfaction of everyone if they are handled with intelligence and recognition of a few simple rules.

1) Protect the flange faces until final assembly.

2) If not protected, clean flange faces of weld spatter, rust, old gasket, etc.

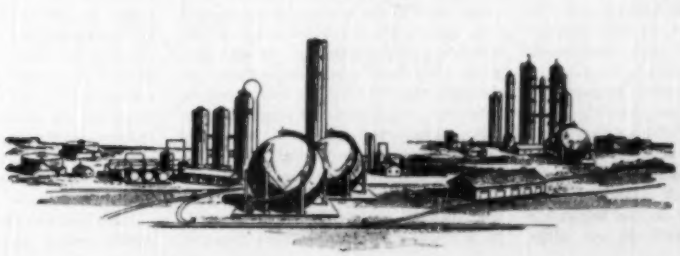
3) Protect the gasket from damage until installed.

4) Center the gasket carefully.

5) Apply bolt stresses uniformly, in small increments, and in the proper sequence.

6) Do not attempt to reuse a gasket; the saving is not worth the probability of unnecessary down-time.

* * *



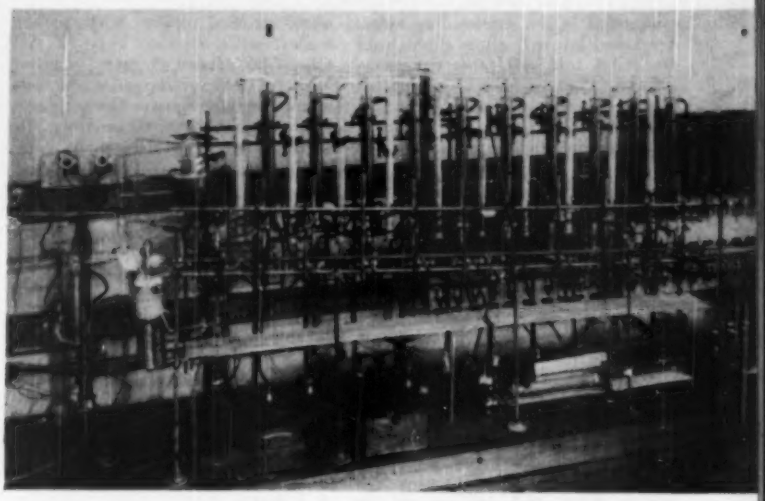


Figure 1. This 10-column countercurrent molecular still developed at the National Bureau of Standards provides an effective means for the separation of liquids which do not differ appreciably in boiling point or which are unable to withstand the high temperatures of ordinary distillation. The columns are arranged in such a way that the condensates move from column to column by gravity from left to right while the residues move similarly in the opposite direction. Countercurrent refluxing with automatic separation of fractions is thus achieved.

Multicolumn Reflux Still Promises Large Savings of Time, Labor and Materials

A MULTICOLUMN countercurrent molecular still designed by Dr. S. L. Madorsky of the National Bureau of Standards appears to have significant advantages for the commercial separation of liquids which differ in their molecular weights or vapor pressures but have similar properties otherwise.

The columns of the still[1] are arranged in such a way that the condensates move by gravity from column to column in one direction while all the residues move similarly in the opposite direction. Countercurrent refluxing with automatic recombination of fractions is thus obtained, and the desired separation of fractions is accomplished in a single operation.

Among important possible applications of the new device are the concentration of vitamins from natural sources and the purification and concentration of vegetable oils, animal fats, lubricating oils, and high-boiling petroleum fractions.

The term "molecular distillation" has been applied to that type of distillation where there is no return of escaping molecules to the evaporating surface. This is accomplished by operating with high-boiling (low-vapor-pressure) liquids under such high vacuum that the mean free path of the escaping molecules is of the order of the distance between the surface of the evaporating liquid and the cooled condensing surface of the still.

In molecular distillation, the relative rates of escape of various kinds of molecules from a composite liquid surface are determined by two factors: 1) the vapor pressure (or the boiling point) of each component, and 2) the average molecular velocity of each component. Since molecular velocities, at a given temperature, are inversely proportional to the square roots of the atomic weights, molecular distillation offers a very practical means for the separation of any mixture of high-boiling substances differing in molecular or atomic weight. It is especially useful in the separation of hydrocarbons which do not differ appreciably in boiling point or are unable to withstand the high temperatures of ordinary distillation.

To avoid the necessity of making repeated cuts, with consequent reduction in output, countercurrent molecular stills have been designed in which a number of single-stage stills are so connected that recombination of fractions takes place automatically by gravity feed.[2] Then the material to be concentrated can be fed into the system at one end, or at the midpoint if both light and heavy fractions are of interest; and the concentrate can be withdrawn continuously. Countercurrent stills of this type consist of a long column placed at a small angle to the horizontal and divided into cells with an evaporating surface of a few square centimeters of each cell. Such stills have one disadvantage. As the openings between the cells must be relatively large, some mixing of vapor takes place; thus each cell represents merely a subdivision of the column and not an actual single-stage column.

In the multicolumn still developed at the Bureau, each column corresponds to a single cell in the earlier types of countercurrent stills. Mixing of the vapor between stages is thus eliminated, with a corresponding increase in the efficiency of the distillation process. To permit operation on a commercial scale, a large evaporating surface is provided, and the evaporating liquid is spread in a thin film to reduce the hold-up. In addition, the thin film is kept in continuous motion over a rough granular surface; this causes thorough mixing and thus prevents depletion of the lighter constituents.

The Bureau's still consists of 10 columns of Pyrex glass, although any number of columns can be used, and they may be made of other materials such as metal. The columns are arranged in a line at successively higher levels and are connected in such a way that the residues or heavy fractions flow from column to column in the downward direction while the condensates or light fractions are pumped from column to column in the upward direction. The over-all operation is such that the light fraction increases in concentration near the lower end.

Each column consists of a central tube, which serves as an evaporator, sur-

rounded by a water-cooled condenser. Below every column is a combination of magnetic pump and reservoir. The liquid is pumped from the reservoir through a feed line into a distributing cup at the top of the column, and from there it spreads over the evaporator in a thin layer. A short ring partition at the lower end of the annular space between the evaporator and condenser forms two concentric annular troughs with a separate outlet from each trough. These troughs and outlets separate the residue flowing down the evaporator from the condensate flowing down the condenser.

The residue from each column, except the lowest, flows into the reservoir of the adjacent lower column; and condensate from each column, except the highest, flows into the reservoir of the adjacent higher column. The residue from the lowest column flows back into its own reservoir, while condensate from the highest column flows into a light fraction receiver and from there into the reservoir of the highest column. A large reservoir surrounded by a nichrome heater serves to degas the liquid before it is introduced into the still. Then, in passing through each feed line the material is preheated to a temperature near that of the evaporator.

The evaporator is 45 cm. long and has an outside diameter of 2.5 cm. This provides an evaporating surface of more than 300 square centimeters. To facilitate uniform distribution and mixing of the liquid layer, the evaporating surface is covered with a thin layer of sintered powdered glass. As the condenser tube has an inside diameter of 4.1 cm., the distance between the evaporating and condensing surfaces across the annular space is 0.8 cm.

The magnetic pump at the base of each column consists essentially of a piston fitting closely within the glass reservoir tube and containing an iron core at its upper end. A solenoidal coil surrounds the glass tube in the region of the iron core. When a current flows in the solenoid, the piston moves up and draws liquid from the reservoir through a check valve into a space below the piston. Then when the current is off, the piston drops by gravity, closing the check valve and forcing the liquid through another check valve into the delivery tube.

In a multicolumn still of this type, unless precautions are taken, a gradual accumulation of liquid in some reservoirs and a depletion in others may be expected. This difficulty is avoided in the Bureau's apparatus in two ways: First, the magnetic pumps are constructed as uniformly as possible, and the amplitudes of the pump pistons are equalized. Second, the evaporating rate is adjusted to a little over one-half the rate at which liquid is pumped into the distributing crown of each column, and the excess condensate is allowed to flow by gravity through overflow tubes from column to column in the downward direction. This arrangement also serves to reflux the light fractions from the light reservoir down to the lowest reservoir.

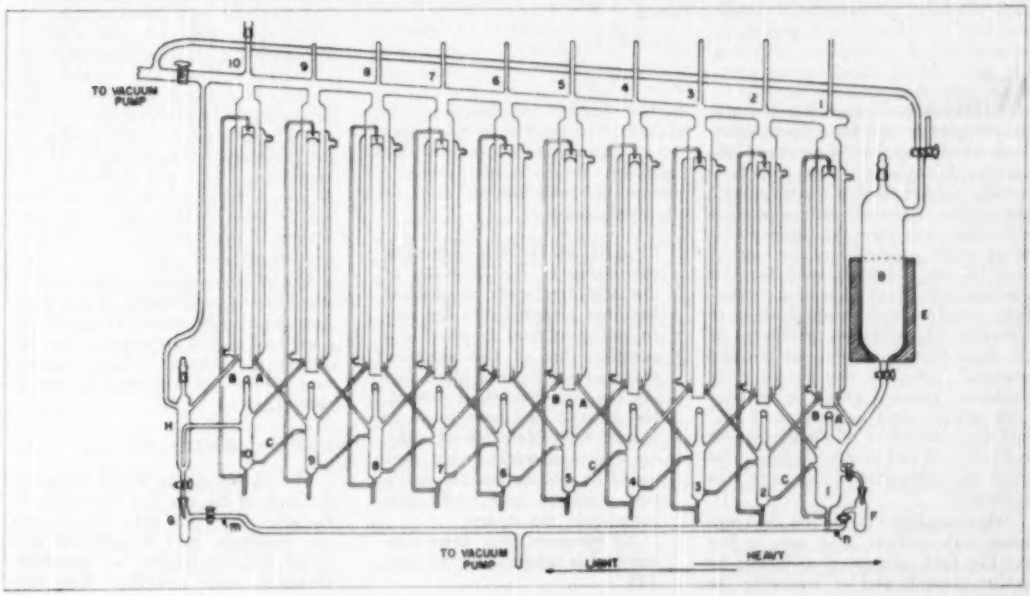
The new multicolumn still should permit large savings of time, labor, and materials since it makes the process of fractionation in molecular distillation a continuous operation. An additional advantage lies in the fact that the entire separation can be carried out without exposing the condensate or residue to the atmosphere; this is particularly desirable for liquids that are susceptible to decomposition upon exposure to air.

REFERENCES

[1] For further details, see A multicolumn countercurrent still, by Samuel L. Madorsky, J. Research NBS 44, 135 (1950) RP 2064.

[2] Countercurrent reflux still for isotope separation, NBS Technical News Bulletin 31, 53 (1947).

Figure 2. Diagram of the multicolumn countercurrent molecular still, developed at the National Bureau of Standards, which effectively separates the constituents of a binary mixture in a single operation. Each column consists of a central tube, which serves as an evaporator, surrounded by a water-cooled condenser. The individual columns are arranged at successively lower levels from left to right. The condensates and residues move by gravity from column to column in opposite directions. Meanwhile, the magnetic pumps in the reservoirs below the columns keep the liquid moving from these reservoirs to the tops of the column. The residue from each column, except the lowest, flows through the outlet A into the reservoir of the adjacent lower column; and the condensate from each column, except the highest, flows through the outlet B into the reservoir of the adjacent higher column. The residue from the lowest column flows back into its own reservoir while condensate from the highest column flows into a light fraction receiver H, and from there into the reservoir of the tenth column. Fractions of condensates in excess of residues flow by gravity from reservoir to reservoir in the light-to-heavy direction through overflow tubes C. The reservoir D, surrounded by a nichrome heater E, serves to degas the liquid before it enters the still. Samples of the concentrates can be removed at cups F and G without interrupting the distillation.



Data are recorded while distillation tests are run on refinery gasolines.

The Chemistry of the Acid Treatment of Gasoline

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WITH few exceptions distillation is the cheapest process for refining petroleum which may thus be separated into various fractions. These fractions usually require further treatment with chemicals to eliminate certain constituents that may have an unfavorable effect on the properties of the finished oils. Of the chemicals used for this purpose sulfuric acid has been successfully applied for the purification of virtually all petroleum products. At the same time it was one of the first materials used for the purpose, for example, Tower treated "coal oils" with sulfuric acid as early as 1782,[1] and the treatment of oil distillates with sulfuric acid and alkali has been used since the beginning of the petroleum industry.[2, 3]

When applied to gasoline the treatment with sulfuric acid usually has the two fold purpose of reducing the sulfur content, and of removing the highly reactive gum-forming hydrocarbons. The purpose of this paper is not to inquire into the reasons for the treatment but to summarize the reactions that can and do take place during the process.

***BY THE AUTHOR'S** statement, this review of the chemistry of the acid treatment of gasoline has been prepared with the view to giving as near as possible a complete list of the reactions that can and do take place during the acid treatment process. No attempt has been made to obtain a complete bibliography, as it is appreciated that such would be well beyond the facilities available, and would only complicate the review.*

All reactions have been summarized in tabular form on page 149.

The chemical reactions that take place during the refining of gasoline with sulfuric acid are by no means simple, and the complex nature of the gasoline itself further complicates the chemistry of the process. In order to understand the action of sulfuric acid on gasoline it is best to consider its action on each class of material present in turn.

Raw gasoline consists essentially of hydrocarbons with small amounts of sulfur compounds and, particularly if the gasoline is obtained from shale oil, also some nitrogen and oxygen compounds. Each group of compounds has somewhat different properties and they may also interact, one with another, in the presence of sulfuric acid. This review deals with the individual reactions of the groups in turn, but there will be some overlapping as the interactions of members of one group with another are dealt with.

The selective action of the acid on the different constituents of the gasoline can also be varied, frequently to a marked degree, by varying the conditions of treatment such as temperature, concentration of the acid, time of contact, etc.

HYDROCARBONS

The hydrocarbons which comprise the bulk of the gasoline (normally to the extent of more than 99 percent) are relatively inert to sulfuric acid under the conditions of treatment. However, some reaction does take

place as shown by the formation of tars and the gasoline loss experienced from the treatment. The hydrocarbons may be divided into the four classes; paraffins, naphthenes, aromatics and olefins, and the reactivity of each class toward sulfuric acid normally varies to a greater extent than does the reactivity of the individual members of the class.

At elevated temperatures all hydrocarbons, without exception, are oxidized by sulfuric acid and consequently the sulfuric acid treatment of gasoline is carried out at atmospheric or subatmospheric temperatures. The literature reveals that many of the results obtained appear anomolous because of failure to record the temperature and strength of the acid employed.

Paraffins

The solubility of the paraffins in sulfuric acid increases with increasing acid strength; and, with the possible exception of the gaseous hydrocarbons, the solubility also increases with the molecular weight of the hydrocarbons.[4,5] The solubility of the pure paraffins in the acid is very small but is increased appreciably by the presence of other materials in the acid sludge.[4]

Sulfuric acid also catalyzes hydrogen exchange, and isomerization of the paraffins[6,7,8] including the racemization of optically active paraffins present.[7,8] Alkyl sulfonic acids, which may be formed during the treatment, have a similar action.[9]

Methane is the only paraffin which is entirely unattacked at normal temperatures by either concentrated or fuming acid,[9] but the action of even fuming acid on the pure higher paraffins is very slow at room temperature, such action leading to the formation of aliphatic sulfonic acids.[10] This oxidation can proceed further. For example, Burkhadt[11] observed that oxidation of n-hexane at 0-10° C. with fuming sulfuric acid gave not only mono- and disulfonic acids, but also caused some dehydrogenation of the paraffin to the olefin, and also formed an appreciable amount of hexyl alcohols. Other products were formed that would be expected from the further reaction of these products with the sulfuric acid. In all oxidation reactions part of the sulfuric acid was reduced and evolved as sulfur dioxide.

Paraffins containing a tertiary carbon atom appear to be more susceptible to attack by sulfuric acid, both with the formation of sulfonic acids, or for further oxidation.[10,12,13]

Under the usual conditions of treatment sulfonation of paraffins does not play a significant role, though it does occur to an appreciable extent in the presence of other more reactive materials.

Another reaction that may take place is for the paraffins to be alkylated by olefins present under the catalytic influence of the sulfuric acid. The low temperature alkylation of iso-butane and iso-pentane with propene and butenes became of great importance during the recent World War as a method of preparing ingredients for the manufacture of aviation gasoline (e.g.[14]). Iso-paraffins are much more readily alkylated than the normal paraffins so any alkylation occurring during the acid treatment would remove some of the more valuable constituents. The alkylation would increase the boiling point of the products to the extent that they could be left in the still bottoms on subsequent distillation.

Naphthenes

The cyclo-paraffins or naphthenes are very similar to the paraffins in their behavior toward sulfuric acid, and are not appreciably attacked by either the concentrated or fuming acid under the usual conditions of refining. They are, however, somewhat more soluble and more reactive than the paraffins and some of the lower members react slowly with ordinary concentrated sulfuric acid.[12,15]

In addition to sulfonation some oxidation and resinification always takes place and aromatic substitution products which have been isolated from the acid sludge from the treatment of pure naphthenes indicating complete dehydrogenation of the naphthenes to the corresponding aromatic hydrocarbons.[12,15,16] Only a small portion of a naphthene so oxidized by sulfuric acid is converted to the aromatic hydrocarbon as the intermediate cyclo-olefins very readily undergo polymerization and disproportionation.[17] These reactions will be discussed more fully under the section on olefins.

Aromatics

Aromatic hydrocarbons are considerably more soluble in and reactive toward sulfuric acid than either the paraffins or most of the naphthenes, but are sufficiently resistant for the sulfonation to be far from complete under the normal conditions of acid treatment.[15] The reactivity of the individual aromatic hydrocarbons varies considerably, toluene and various other homologues being appreciably attacked by 91-92 percent acid while benzene, p-di-substituted benzenes and tetrasubstituted benzenes are not readily attacked by acid weaker than 95 percent.[18]

The main products of the action of sulfuric acid on aromatic hydrocarbons are the sulfonic acids but, in the presence of olefins, some alkylation can take place as well.[19] For example, Condon and Matuszak[20] found that benzene was alkylated with propene 350 times as fast as iso-butane, in the presence of concentrated sulfuric acid; alkyl benzenes are alkylated even more readily than benzene.[21] The alkylation of indan and tetralin, in which a naphthene ring is fused to a benzene ring, caused substitution in the aromatic ring indicating the comparative reactivities of the two-ring systems.[22] Alkane sulfonic acids (as from the sulfonation of paraffins or the oxidation of disulfides q.v.) also act as mild alkylation catalysts for the alkylation of aromatics with olefins.[23]

Some rearrangement of the side chains of polyalkyl benzenes has been observed under the influence of concentrated sulfuric acid, while the "autoalkylation" of the nucleus by an olefinic side chain frequently occurs.[6]

Olefins

Olefins are by far the most reactive of the different classes of hydrocarbons toward sulfuric acid. The reactions discussed will be those due to the presence of the carbon-carbon double bond while the remainder of the molecules will react according to its own particular properties whether they be paraffinic, naphthenic or aromatic.

Olefins are, as a rule readily attacked by sulfuric acid of even as low a concentration as 75 percent but the reactivity varies for the different members of the series, some of them requiring drastic treatment for removal. These differences in reactivity have sometimes been used for analytical purposes, the activity of the branched chain olefins being greater than that of the straight-chain molecules. At the same time the reactivity decreases with increasing molecular weight beyond the pentenes and hexenes.[15]

In common with other cationic reagents sulfuric acid readily adds to the olefinic double bond, the addition normally following Markofnikoff's rule in that the sulfate group adds to the carbon atom with the lesser number of hydrogen atoms. The product thus formed is a secondary or tertiary alkyl sulfate.[15] This acid alkyl sulfate can react with a further olefin molecule to form a dialkyl sulfate, which is readily soluble in gasoline.[15]

The reaction which gives rise to the alkyl sulfates can cause isomerization of the olefin by shift of the double bond, a change which may occur either independently of, or prior to the condensation with the molecule of sulfuric acid. A similar result can be obtained by the decomposition of the

alkyl sulfate to regenerate an olefin and sulfuric acid.

The hydrolysis of the alkyl sulfates can give rise to secondary or tertiary alcohols which may be present in small amount in the acid sludge or possibly also in the gasoline. It has also been observed that the formation of alcohols is possible without the intermediate formation of esters.[10,24]

The acid alkyl sulfates may be removed from the treated gasoline by means of a subsequent water or caustic wash but the dialkyl sulfates are not removed by such treatment. It is interesting to note at this point that as much as 3.1 percent of sulfuric acid (presumably present as dialkyl sulfates) was found in a refined kerosine in 1875.[25]

On redistillation of the treated gasoline these dialkyl sulfates decompose with the liberation of sulfur dioxide and the formation of various oxidation products.

Another of the reactions of olefins catalysed by sulfuric acid is their polymerization. This reaction is competitive with the alkyl sulfate formation and the polymer yield increases with increasing molecular weight, octenes and higher olefins yielding polymers almost exclusively.[24] Although they still contain a double bond in the molecule these polymers are very stable to sulfuric acid and frequently do not polymerize further under normal refining conditions. The analogous polymerization of butenes has been employed for the preparation of aviation gasoline constituents.[14] Alkane sulfonic acids (as from the sulfonation of paraffins or the oxidation of disulfides q.v.) also act as mild olefin polymerization catalysts.[23]

The mechanism of the polymerization reaction appears to be analogous to the alkylation of paraffins with olefins.[14]

Cyclo-olefins tend to be more reactive than the open chain olefins and isomerization of the polymers takes place readily, for example, cyclohexene in 97 percent sulfuric acid at 0° C. undergoes polymerization accompanied by change in ring size and disproportionation to yield 1-cyclohexyl 2- and 3-methyl cyclopentane, and an unsaturated dimeric fraction which appears to contain diolefins derived from cyclohexyl-methylcyclopentane.[17]

This disproportionation of the olefin polymer is not confined to the polymers of the cyclo-olefins but appears to be quite general[24,26,27] although open chain olefin polymers are normally much less reactive, part of the polymer giving hydrogenated dimers, trimers, etc., at the expense of another part which gives rise to highly unsaturated hydrocarbons. Part of these are ultimately further condensed to give tars.

Diolefins, containing two double bonds in the molecule, naturally have a somewhat greater chance of reaction than the mono-olefins. Unless the double bonds are conjugated the diolefins are not detrimental to the storage stability of the gasoline. Conjugated olefins are much more reactive and are readily polymerized, this being the only beneficial action of sulfuric acid on any of the hydrocarbons during the treatment of gasoline.

Because of the effect of the double bond on increasing the activity of the molecule as a whole, olefins are more readily attacked by sulfuric acid with the formation of various oxidation products such as sulfonic acids, etc.

Sulfur dioxide, which is nearly always present in the acid treatment mixture from the reduction of part of the sulfuric acid, can react with certain olefins to form sulfones. This action of sulfur dioxide on most simple olefins is negligible but is catalyzed by the presence of dissolved oxygen[28] or organic peroxide.[29] The reaction products may be either simple or polysulfones, or they may be heteropolymeric with the properties of plastics.[18]

Conjugated diolefins react readily with liquid sulfur dioxide to yield both polymeric and unpolymerized sulfones. Isopropene, for example, condenses with sulfur dioxide to give beta methyl dihydrothiophene sulfone.[30] These compounds are gasoline soluble and are decomposed into their components by heating to 120° C.,[12] a reaction which may help to explain the evolution of sulfur dioxide on heating undistilled acid treated gasoline above this temperature.

Olefins also react with other gasoline constituents and such reactions have been dealt with in the discussion on the reactions of paraffins, aromatics, hydrogen sulfide, mercaptans, thiophenes, phenols and aldehydes.

SULFUR COMPOUNDS

The sulfur in any gasoline is normally present in a variety of forms, all of which are removed by concentrated sulfuric acid to some extent. They include hydrogen sulfide and (occasionally) elemental sulfur, mercaptans, mono- and di-sulfides, and cyclic sulfur compounds such as thiophenes and thiophanes. Treated gasolines sometimes also contain polysulfides, sulfones, and alkyl sulfates. In rare cases a gasoline may contain a small amount of carbon disulfide.

Sulfuric acid acts toward these sulfur compounds in two ways. Its preferred action is that of selective extraction the selectivity being greater at low temperatures. The second mode of action is oxidation which will be dealt with more fully later. At the same time the remaining portions of the molecules of the sulfur compounds may be attacked by the acid according to their nature.

The action of sulfuric acid on the various types of sulfur compounds will be discussed in turn.

Hydrogen Sulfide

This material will be almost, if not completely, removed by the pretreat caustic wash usually given the raw gasoline prior to acid treatment. It has recently been observed that, in the presence of olefins, the hydrogen sulfide has been alkylated with the formation of mercaptans, the sulfuric acid acting as catalyst.[31] The formation of disulfides was also observed but they were most probably formed as a secondary product of the reaction of the mercaptans with the sulfuric acid (q.v.).

Sulfuric acid stronger than 93 percent oxidizes hydrogen sulfide to elemental sulfur with the liberation of sulfur dioxide.[13]

Mercaptans

The principal reaction between mercaptans and sulfuric acid results in the formation of organic disulfides,[12,15,22] a reaction which was first recognized by Erlenmeyer.[23] The reaction appears to involve the intermediate formation of alkyl acid thiosulfates and dialkyl dithiosulfates,[22] the latter decomposing with the formation of the dialkyl disulfide and sulfur dioxide. It has been shown that, with an excess of sulfuric acid and sufficient contact time, this reaction will go to completion.[22] However, this method of sweetening a sour gasoline is not practiced because of the large amount of acid required and the large treating losses that would be experienced.

By secondary reactions part of the disulfide may be oxidized to the corresponding sulfone ($RS.SO_2R$) while some of the sulfuric acid may be reduced to elemental sulfur.[24] There is also evidence suggesting that reaction of the mercaptans with elemental sulfur during the treatment with sulfuric acid can give rise to the formation of trisulfides.[35]

In a manner analogous to the alkylation of hydrogen sulfide by olefins[31] mercaptans may be further alkylated by olefins with the formation of dialkyl sulfides.[36,37,38,39] This alkylation reaction can take place directly or through the reaction of the mercaptan with the alkyl sulfuric acids formed by the interaction of olefins with the

sulfuric acid.[40] It is also reported that mercaptans will condense with aromatic sulfonic acids with the formation of the corresponding aryl alkyl sulfide.[41]

Oxidized gasolines can contain a small amount of aldehydes or ketones and mercaptans readily condense with these materials to form mercaptals and mercaptoles respectively.[13] These have structures analogous to acetals.

Alkyl Sulfides

Dialkyl sulfides are soluble in concentrated sulfuric acid, and thus an appreciable proportion of these materials in gasoline are physically extracted during the treatment, even with the relatively small proportion of acid used in commercial operation.[4, 15] The alkyl sulfides are normally precipitated unchanged on dilution of the acid sludge with water and this method has been used as a method of isolation and recovery of these materials from a gasoline (e.g. 42).

There is also some evidence suggesting that part of the sulfides may be oxidized by the acid to the sulfones.[4]

The thiophanes, or tetra hydro thiophenes, are cyclic sulfides but behave toward concentrated sulfuric acid in exactly the same manner as the dialkyl sulfides (e.g. 42). Although the reaction does not appear to have been reported, it is possible that some dehydrogenation of the thiophanes to thiophenes may take place.

Alkyl Disulfides

The action of alkyl disulfides with concentrated sulfuric acid is very much the same as that of the mono-sulfides in that the main action is purely their physical (solvent) extraction. They are, however, somewhat less soluble in the acid than the mono-sulfides.[15] Part of the disulfide may be oxidized to the corresponding sulfone ($RS.SO_2R$),[24] and it seems likely that further oxidation could give rise to the disulfone, and then to the alkyl sulfonic acids.

Polysulfides

These materials are not normally present in a gasoline which is being acid treated, and very little work appears to have been carried out on their reaction with concentrated sulfuric acid. From a general understanding of their properties, however, it is possible to say that they would be partially extracted by the acid but to a somewhat lesser extent than the mono- and di-sulfides, and that they would be somewhat more susceptible to oxidation.

Elemental Sulfur

Traces of free sulfur initially present in a gasoline or formed by the atmospheric oxidation of hydrogen sulfide, are relatively unaffected by the sulfuric acid, but may be oxidized to sulfur dioxide on sufficiently long standing.

Octane Machines Check Gasoline Quality

Carbon Disulfide

Carbon disulfide is unaffected by any strength of sulfuric acid and remains unchanged in the treated gasoline.[15, 42]

Thiophenes

It is doubtful whether thiophenes are present in straight-run distillates, but they are definitely present in cracked gasolines.[24] Thiophenes are unsaturated cyclic sulfides but their aromatic character is stronger than their sulfide character. They are somewhat more soluble in concentrated sulfuric acid than is benzene, a property which has been employed for the removal of thiophene from coal tar benzol (e.g. 44), the thiophene being at least partly recovered unchanged on dilution of the acid sludge with water.

With 93 percent or stronger acids thiophenes are slowly sulfonated, the thiophene sulfonic acids being soluble in the acid sludge to about the same extent as the alkyl disulfides.[15, 32]

As is to be expected from their aromatic nature, thiophenes may be alkylated by olefins in the presence of sulfuric acid,[45] a reaction which has been proposed for their removal from benzene by the addition of some olefins prior to acid treatment.[46] This same reaction appears to have a significant effect in the desulfurization of cracked shale gasoline by treatment with sulfuric acid in that a large proportion of the sulfur reduction obtained occurs on the redistillation of the acid treated gasoline, the re-run bottoms containing several percent of sulfur.[47]

Condensation of thiophenes with reactive olefins can give rise to highly colored products; thus thiophene and cyclopentadiene may form a red dye while thiophene and cyclohexane yield a green dye.[15, 48]

Thiophthenes (thiopheno-thiophenes) polymerize and give rise to a

variety of colors with concentrated sulfuric acid[49] and it may be likely that the strong colors sometimes observed in gasoline after acid treatment are related to these coloring matters.

Oxidized gasolines may contain a small amount of aldehydes and ketones. In the presence of sulfuric acid thiophene has recently been condensed with formaldehyde to yield a resin which is apparently analogous to phenol-formaldehyde resins in structure.[50]

In the presence of ammonium salts (or ammonia and acid) thiophenes readily condense with formaldehyde to thienyl-amines,[51, 52] while in the presence of alkylamine salts, nitrogen free polymers are obtained.[51] They appear to be dithienyl methanes.[52] If nitrogen compounds and aldehydes are present in the gasoline together during the acid treatment there appears to be no reason why these reactions would not take place to some extent.

Sulfoxides, Sulfones and Alkyl Sulfates

These materials are formed in a gasoline by treatment with sulfuric acid, as they do not appear to be present in untreated gasolines. They are all more soluble in the acid layer than in the gasoline so they are normally extracted almost completely by solution in the acid sludge.[15, 48] In one case, in the author's experience, however, this extraction was apparently inefficient on one batch of gasoline, due to operating troubles, Monoalkyl sulfates were readily removed by caustic and water washing but the product still decomposed at about 250° F. with the liberation of sulfur dioxide and the deposition of a black solid which readily fouled the reboiler tubes in the re-run unit to such an extent that operation was impossible. The trouble was finally overcome by re-acid treating the product in order to solvent extract the troublesome materials. The full reason for their presence in the treated gasoline was unknown, as was the exact nature of the troublesome materials, but, from their properties, it appears that they were dialkyl sulfates and/or the sulfones formed by the addition of sulfur dioxide to conjugated diolefins.

NITROGEN COMPOUNDS

Because of the usual distribution of nitrogen in crude oils, cracked gasolines are more likely to contain some nitrogen compounds than straight-run gasolines, while they are always present to some extent in the gasoline prepared from crude shale oil either by distillation or cracking. Ammonia may be present in a cracked gasoline but would normally be distilled off during stabilization. Otherwise, it would dissolve in and neutralize the acid if not removed by a previous water wash. Of the organic nitrogen compounds present pyridines, pyrroles and nitriles are the most likely to be present though the possibility of the presence of alkylamines must not be overlooked. These would, however, react with the acid in a manner analogous to that of ammonia and be removed.

Pyridines

Pyridine and its homologues are basic and largely dissolve in the sulfuric acid from which they may be recovered by rendering it alkaline.

The alkyl side chains of the pyridine homologues are slowly oxidized by sulfuric acid to give the corresponding carboxylic acids[53] though these materials were not detected in the sludge from the acid treatment of a cracked shale gasoline initially containnig approximately 0.3 percent by volume of pyridines.[54]

The alpha and gamma side chains of alkyl pyridines are reactive and may condense with aldehydes or ketones if these are present, to give beta hydroxy alkyl pyridines which can dehydrate to the corresponding alkenyl pyridines (e.g.[55, 56]).

Pyrroles

Pyrroles are very weakly basic but are almost completely removed from a gasoline by treatment with concentrated sulfuric acid. When present in the orginal gasoline they may be detected in the acid sludge, or in the tar bases (pyridine compounds) isolated from the sludge, or in the steam evolved on boiling the hydrolyzed acid after dilution.[54, 57] At the same time pyrroles are readily polymerized by acids giving a "pyrrole red." This type of material can actually be deposited on standing from an oil or gasoline which contains an appreciable amount of pyrroles,[59] and it also appears to be associated with the gum-forming characteristics of gasolines containing pyrroles.[57]

In the presence of aldehydes pyrroles give higher molecular weight condensation products[59, 60] which would be separated with the acid sludge. Such condensation would, under normal conditions, account for only a small amount of pyrrole because of the low concentration of aldehydes etc. in the gasoline.

Nitriles

Only traces of nitriles are likely to be present in a gasoline at the most. They appear to be largely dissolved by the sulfuric acid without decomposition and thus removed with the acid sludge,[44] and they have been detected in the bases isolated from the acid sludge from the acid treatment of a cracked shale gasoline in amount equivalent to an initial concentration in the raw gasoline of 1.5 parts per million.[61]

It is possible that a certain amount of hydrolysis of the nitrile could take place under the catalytic influence of the sulfuric acid. This, however, is not likely with the concentrated acid and would be more probable with dilute acid, as for example in the sludge after dilution with water.

OXYGEN COMPOUNDS

The oxygen compounds present in gasoline are normally either carboxylic acids (naphthenic acids) or phenols (tar acids) though small amounts of aldehydes, ketones and peroxides may be present due to atmospheric oxidation. The first two classes of compounds are normally almost completely removed from the gasoline by means of a caustic wash prior to the acid treatment, while the small amounts of the other materials that may be present are not in sufficient quantity to significantly affect the over-all result of the treatment. Their reactions are, however, of general interest and are therefore included mainly for the sake of completeness.

Carboxylic Acids

Naphthenic acids are completely soluble in the sulfuric acid [15] so those initially present in a gasoline will be largely extracted unchanged by the acid sludge. These compounds do not normally react with sulfuric acid[62] though the radical carrying the carboxyl group will be affected according to its nature. Under some conditions, particularly if the temperature is slightly elevated (to about 100° F.), olefins can condense with carboxylic acids in the presence of sulfuric acid, to give esters which are soluble in the acid sludge.[12, 63]

Phenols

Phenols are appreciably soluble in the acid sludge as shown by the isolation of approximately one percent of tar acids by volume from the acid sludge from the treatment of a gasoline which contained appreciably less than 0.05 percent of tar acids by volume.[54]

Pure phenols are fairly readily sulfonated by concentrated sulfuric acid but, in solution in gasoline and under usual plant operating conditions, they are sulfonated only to approximately the same extent as the aromatic hydrocarbons present in the gasoline.[64]

It appears that phenols may con-

dense with certain naphthenes during the acid treatment[65] while they can also form colored condensation products with olefins.[48] Because of the reactivity of the aromatic ring in phenols it is not surprising that they may be alkylated by olefins in the presence of sulfuric acid,[66] a reaction which has commercial application in the preparation of alkyl phenols for use as gasoline oxidation inhibitors, etc.[67] The high boiling residue of the tar acids isolated from an acid sludge[54] indicated that approximately 6 percent of the tar acids had been thus alkylated.

It is also reported that some tar acids are sulfonated, some oxidized, and some are first oxidized and then dissolved in the acid.[15, 68]

The condensation of phenols with aldehydes is well known, particularly with regard to the reaction with formaldehyde in the manufacture of synthetic resins. Similar, but usually less complex condensation products may be obtained with other aldehydes.[69]

Aldehydes, Ketones, Etc.

These materials are normally present in gasoline to only a small extent, for example, approximately 0.001 percent of acetaldehyde has been found in a Pennsylvanian petroleum.[4, 70] When present in a gasoline, aldehydes and ketones are usually the secondary products of atmospheric oxidation. Ketones have been isolated from acid sludges,[4, 71, 77] but it is likely that they were formed by the oxidation in the sludge of the secondary alcohols or alkyl sulfates which were initial products of the action of the acid on olefins.

Probably the principal reaction of aldehydes and ketones that will take place during the acid treatment process will be their polymerization by the well known aldol condensation. This reaction is amply discussed in virtually every text book on organic chemistry and no more need be said here of it other than that the products are more complex hydroxy or unsaturated aldehydes or ketones.

The reactions of mercaptans, thiophenes, pyridines, pyrroles and phenols with aldehydes and ketones have been dealt with briefly in the sections dealing with these various minor constituents of the gasoline.

In the presence of concentrated sulfuric acid, aromatic hydrocarbons will condense with formaldehyde to give insoluble resins[4, 69, 73] a reaction which has been called the "Formolite" reaction. The probable reaction mechanism appears to be along the same lines as the condensation of phenols with formaldehyde. This reaction was investigated by many workers, but it now appears to have little application in the analysis or refining of petroleum products, though parallel reactions may take place between the aromatics and aldehydes present during acid treatment.[69]

Alkylation Plant

In the presence of concentrated sulfuric acid olefins can form high molecular weight condensation products with formaldehyde[4, 69] or furfural.[72] These products include glycols[72, 74] and may be either liquid or solid depending on the olefin and the conditions.

Since the condensation of aldehydes with 1-alkenes to form ketones has been found to be catalyzed by acyl peroxides[75] it is possible that organic hydro-peroxides (from atmospheric oxidation) could have a similar catalytic action in the presence of concentrated sulfuric acid.

Another possible reaction that may take place is the condensation of aromatic aldehydes with higher alcohols (from the hydration of olefins or the oxidation of hydrocarbons) to give highly colored oxidation products.[76] The mechanism of the reaction appears to involve the oxidation of the alcohol and an aldol condensation with the aldehyde.[77]

EFFECT OF TREATMENT CONDITIONS

The extent to which the different reactions take place during the acid treatment varies with the nature of the gasoline, and the conditions of treatment such as the amount and concentration of the acid, and the temperature and time of contact. The main purpose of this paper is to record the qualitative effects of the nature or composition of the gasoline on the treatment, but it would not be complete without a brief mention of the effects of the conditions of treatment.

For special purposes, such as the extraction of basic nitrogen compounds, quite dilute sulfuric acid may be used, though such practice is uncommon. Commercial concentrated acid is normally used for the treatment of gasoline for gum stability or sulfur removal, though occasional processes using dilute or fuming acid have been patented. An acid of 40 percent concentration has some polymerizing activity, particularly on cracked distillates[78] while it has practically no desulfurization action at a concentration of 60 percent or less.[15]

It is seldom that more than 6 pounds of acid is used per barrel of gasoline[15] while, with most gasolines, the treatment loss is less than 5 percent. The desulfurization of some cracked gasolines to meet some market specifications can, however, require prohibitive amounts of acid. For example, reduc-

ing the sulfur content of a shale gasoline from 0.8 percent to 0.10 percent required 75 pounds per barrel and involved a loss of 40 percent.[79] Similarly, reducing the sulfur content of a Californian cracked gasoline from 0.88 percent to 0.19 percent required 40 pounds per barrel and involved a treatment loss of 19.1 percent.[15] These results help to illustrate the difference shown by different oils with respect to treatment loss and sulfur reduction.

The oxidizing, sulfonating, and polymerizing activity of sulfuric acid is greatly reduced at low temperatures, while its selective solvent action for sulfur compounds is retained and possibly enhanced. This is the basis of the Strathcold acid-treating process in which the treatment is normally carried out at a maximum temperature of the order of 20° F. This process gives smaller treatment losses and greater sulfur reductions than conventional atmospheric temperature treatment (e.g.[15]).

Additional time of contact between the acid and the gasoline beyond that required for the equilibrium for the solvent extraction of the sulfur compounds to be approached, allows the unwanted side reactions of polymerization, alkylation, sulfonation and oxidation to proceed unnecessarily. In modern equipment the time of contact is frequently between 10 and 20 seconds.[15,80]

One other factor that can seriously influence the process is the purity of the acid used. This factor is not as important as it was previously because of the increasing proportion of contact process to chamber process acid available. The latter usually contains traces of oxides of nitrogen or nitric acid, and these have long been known to be detrimental to the quality of the finished product.[4,15,81] Selenium oxide is also detrimental if present to the extent of more than 0.05-0.07 percent.[82] In either case, however, redistillation of the treated product should eliminate much of the trouble caused by these impurities.

Recovered or reclaimed acid usually contains organic substances equivalent to 1-5 percent of carbon and these appear to have no detrimental effect on its use.[15]

Processes have been described or patented in which various agents have been added to the acid in order to modify its action in some way, but it seems unlikely that any of these processes have achieved commercial exploitation. For example, the addition of 2.75 percent of boric acid to 93 percent sulfuric acid has been claimed to prevent the sulfonation of aromatics,[83] while the addition of copper sulfate has been claimed to increase the removal of sulfur compounds.[84]

GENERAL DISCUSSION

A large number of reactions has been listed as possibly occurring during the acid treatment of gasoline. Many of the reactions will take place to only a negligible extent if at all except under abnormal circumstances such as excessive proportion of acid or time of contact with an abnormally high reaction temperature. Various other reactions cannot have a significant effect on the course of the treatment because the reactants are not present in sufficient quantity. However, all these reactions have been included because, if operating troubles are experienced on the acid treatment plant, conditions become abnormal; and with the development of new cracking techniques and various methods for the synthesis of gasolines, constituents which at present occur only in small amounts, may be present to a greater extent in future gasolines where their influence on the course of acid treatment may not be negligible. At the same time, an understanding of the reactions that can take place may assist in the improvement of the efficiency of the acid treatment process.

TABULATION OF RESULTS

The products of the reactions which take place during the treatment may be soluble in and completely extracted by the acid sludge, remain dissolved in the gasoline, or be partitioned between two phases. It is usual to redistill a gasoline after acid treatment in order to remove as bottoms the polymers and other high molecular weight, gasoline soluble reaction products, though this is sometimes unnecessary with straight-run or natural gasolines that have been subjected to a mild treatment. All the reactions discussed have been summarized in the accompanying table, together with the fluid destination of the reaction products either into the gasoline product, re-run bottoms or the acid sludge.

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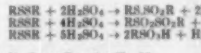
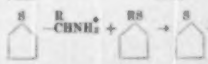
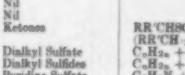
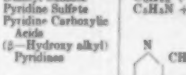
Reactions That Can Take Place During the Acid Treatment of Gasoline

Reaction No.	Constituent	Reactant	Reaction Type	Product	Equation of Reaction	Destination of Product[a]	Desirability[b]	Significant[c]	References
1	Paraffins	Sulfuric Acid	Physical Solution	Nil		S	No	No	4,5
2	Paraffins	Sulfuric Acid	Hydrogen Exchange	Same as Reactant		G	OK	No	6,7,8
3[4]	Paraffins	Sulfuric Acid	Isomerization	Iso-paraffin		G	OK	No	6,7,8
4[5]	Paraffins	Sulfuric Acid	Sulfonation	Alkyl Sulfonic Acid	$C_nH_{2n+2} + 2H_2SO_4 \rightarrow C_nH_{2n+1}SO_3H + 2H_2O + SO_2$	S	No	No	10,11
			Sulfonation	Disulfonic Acids[c]	$C_nH_{2n+1}SO_3H + 2H_2SO_4 \rightarrow C_nH_{2n}(SO_3H)_2 + 2H_2O + SO_2$	S	No	No	11
5[6]	Paraffins	Sulfuric Acid	Oxidation	Olefin	$C_nH_{2n+2} + H_2SO_4 \rightarrow C_nH_{2n} + 2H_2O + SO_2$	G	OK	No	11
6[6]	Paraffins	Sulfuric Acid	Oxidation	Alcohols	$C_nH_{2n+2} + H_2SO_4 \rightarrow C_nH_{2n+1}OH + H_2O + SO_2$	S	No	No	11
7[2,3,4]	Paraffins	Olefins	Alkylation	Higher M.W. Paraffin	$C_nH_{2n+2} + C_mH_{2m} \rightarrow C_{n+m}H_{2(n+m)+2}$	B	No	Yes	e.g.14
8	Naphthenes	Sulfuric Acid	All Reactions as for Paraffins						12,13
9	Naphthenes	Sulfuric Acid	Oxidation	Aromatics	$C_nH_{2n} + 3\ H_2SO_4 \rightarrow C_nH_{2n-6} + 6H_2O + 3SO_2$	G	No[d]	No	12,15,16
10[14]	Naphthenes	Phenols	Condensation	"Condensation Products"		S,B	No	No	65
11	Aromatics	Sulfuric Acid	Physical Solution	Nil		S	No	No	
12	Aromatics	Sulfuric Acid	Side Chain Isomerization	Isomeric Aromatics		G	No	No	6
13	Aromatics	Sulfuric Acid	Sulfonation	Aryl Sulfonic Acids[c]	$C_nH_{2n-6} + H_2SO_4 \rightarrow C_nH_{2n-7}SO_3H + H_2O$	S	No	Yes	15,18
14[23]	Aromatics	Olefins	Alkylation	Alkyl Aromatics	$C_nH_{2n-6} + C_mH_{2m} \rightarrow C_nH_{2n-7}C_mH_{2m+1}$	B	No	No	19
15[20]	Aromatics	Aldehydes	"Formolite" Reaction	Resins		S	No	No	4,69,73
16	Olefins	Sulfuric Acid	Physical Solution	Nil		S	No	No	
17	Olefins	Sulfuric Acid	Isomerization	Isomeric Olefin		G	OK	No	6
18	Olefins	Sulfuric Acid	Esterification	Alkyl Sulfate	$C_nH_{2n} + H_2SO_4 \rightarrow C_nH_{2n+1}HSO_4$	S	No	Yes	15
19[20]	Olefins	Alkyl Sulfates	Esterification	Dialkyl Sulfate	$C_nH_{2n} + RHSO_4 \rightarrow C_nH_{2n+1}RSO_4$	Sa	No	Yes	15
20	Olefins	Water (dilute acid)	Hydration	Alcohol	$C_nH_{2n} + H_2O \rightarrow C_nH_{2n+1}OH$	S	No	No	10,24
21	Cyclo-Olefins	Sulfuric Acid	Oxidation	Aromatics	$C_nH_{2n-2} + 2\ H_2SO_4 \rightarrow C_nH_{2n-6} + 4H_2O + 2SO_2$	G	OK[f]	No	12,15,17
22[7]	Olefins	Paraffins[g]	Alkylation	Higher M.W. Paraffins	$C_nH_{2n} + C_mH_{2m-2} \rightarrow C_{n+m}H_2\ (_{c=m})\ T_2$	B	No	No	14
23[14]	Olefins	Aromatics	Alkylation	Alkyl Aromatics	$C_nH_{2n} + C_mH_{2m-6} \rightarrow C_nH_{2n+1}C_mH_{2m-7}$	B	No	No	19
24	Olefins	Olefins	Polymerization	Olefin Polymer	$C_nH_{2n} + C_mH_{2m} \rightarrow C_{n+m}H_{2(n+m)}$	B	No	Yes	12,15,24
25	Conjugated Diolefins	Olefins	Polymerization	Polymer		B	Yes	Yes	12,15,24
26[20]	Olefins	Aldehydes	Condensation	Glycols		S	No	No	72,74
27[21]	Olefins	Aldehydes	Condensation	Resins		S	No	No	69,72
28[22]	1-Alkenes	Aldehydes in presence of Acyl peroxides	Condensation	Ketones	$R.CH{=}CH_2 + HCO.R' \rightarrow R.CH_2.CH_2COR'$	S,B	No	No	75
29	Olefins	Sulfur Dioxide	Condensation	Sulfones and Polymeric Sulfones		S	No	No	15,38,39
30	Conjugated Diolefins	Sulfur Dioxide	Condensation	Dihydrothiophene Sulfones		S,G	No	No	12,30
31[20]	Olefins	Hydrogen Sulfide	Alkylation	Mercaptans	$C_nH_{2n} + H_2S \rightarrow C_nH_{2n+1}SH$	G	No	No	31
32[20]	Olefins	Mercaptans	Alkylation	Dialkyl Sulfides	$C_nH_{2n} + RSH \rightarrow C_nH_{2n+1}SR$	G,B	OK[h]	No	36,37,38, 39,40
33[20]	Olefins	Thiophenes	Alkylation	Alkyl Thiophenes	$C_nH_{2n} + C_mH_{2m-6} \rightarrow C_nH_{n+1}C_mH_{2m-6}$	B,G,S	Yes[h]	Yes	45,46,47
34[21]	Olefins	Thiophenes	Condensation	"Colored Products"		B,S	Yes[h]	No	15,48,49
35	Olefins	Phenols	Alkylation	Alkyl Phenols	$C_nH_{2n} + C_mH_{2m-7}OH \rightarrow C_nH_{2n+1}.\ C_mH_{2m-6}OH$	S,B	No	No	64,66
36	Olefins	Phenols	Condensation	Colored Condensation Products		S,B	No	No	48
37[20]	Olefins	Naphthenic Acids	Esterification	Esters	$C_nH_{2n} + RCO.OH \rightarrow RCO.OC_nH_{2n+1}$	S	No	No	12,63
38	Olefin Polymers[i]	Sulfuric Acid	Disproportionation[m]	Paraffins and Diolefins[m]	$2C_nH_{2n} \rightarrow C_nH_{2n+2} + C_nH_{2n-2}$	S,B	OK	Yes	17,34, 36,37
39	Hydrogen Sulfide	Sulfuric Acid	Oxidation	Sulfur	$H_2S + H_2SO_4 \rightarrow S + 2H_2O + SO_2$	B	No	No	15
40[21]	Hydrogen Sulfide	Olefins	Alkylation	Mercaptans	$C_nH_{2n} + H_2S \rightarrow C_nH_{2n+1}SH$	G	No	No	31
41	Mercaptans	Sulfuric Acid	Esterification	Alkyl Thiosulfate	$RSH + H_2SO_4 \rightarrow RS.SO_3H + H_2O$				32
			and	Dialkyl Dithiosulfate	$RSH + RS.SO_3H \rightarrow (RS)_2SO_2 + H_2O$				32
			Decomposition	Dialkyl Disulfide	$(RS)_2SO_2 \rightarrow RSSR + SO_2$	G,B,S	OK[h]		32
			Oxidation (over-all)		$2RSH + H_2SO_4 \rightarrow RSSR + SO_2 + 2H_2O$				12,15, 32,33
42[20]	Mercaptans	Sulfuric Acid and Sulfur	Oxidation	Dialkyl Trisulfide	$2RSH + H_2SO_4 + S \rightarrow R_2S_3 + SO_2 + H_2O$	(,B,S	No[h]	No	35
43[21]	Mercaptans	Olefins	Alkylation	Dialkyl Sulfides	$C_nH_{2n} + RSH \rightarrow C_nH_{2n+1}SR$	G,B	OK[h]	No	36,37, 38,39
44	Mercaptans	Alkyl Sulfates	Alkylation	Dialkyl Sulfides	$RSH + R'HSO_4 \rightarrow RSR' + H_2SO_4$	G,B	OK[h]	No	40
45	Mercaptans	Aryl Sulfonic Acids	Condensation	Alkyl Aryl Sulfides	$RSH + ArSO_3H \rightarrow RSAr + H_2O + SO_2$	B,G,S	Yes[h]	No	41
46	Mercaptans	Aldehydes	Condensation	Mercaptals	$2\ RSH + R'CHO \rightarrow R'CH(SR)_2 + H_2O$	S,B	Yes	No	12
47	Mercaptans	Ketones	Condensation	Mercaptoles	$2\ RSH + R'_2CO \rightarrow R'_2C(SR)_2 + H_2O$	S,B	Yes	No	12
48	Alkyl Sulfides	Sulfuric Acid	Physical Solution	Nil		S	Yes	Yes	4,15
49	Alkyl Sulfides	Sulfuric Acid	Oxidation	Sulfones	$R_2S + 2H_2SO_4 \rightarrow R_2SO_2 + 2H_2O + 2SO_2$	S,B	Yes	No	4
50	Thiophenes	Sulfuric Acid	Oxidation	Thiophenes		G	No	No	Possible
51	Alkyl Disulfides	Sulfuric Acid	Physical Solution	Nil		S	Yes	Yes	15
52	Alkyl Disulfides	Sulfuric Acid	Oxidation	Monosulfone	$RSSR + 2H_2SO_4 \rightarrow RS.SO_2R + 2H_2O\ 1\ 2SO_2$	S	Yes	No	34
			Oxidation	Disulfone	$RSSR + 4H_2SO_4 \rightarrow RSO_2SO_2R + 4H_2O + 4SO_2$	S	OK	No	Possible
			Oxidation	Sulfonic Acids	$RSSR + 5H_2SO_4 \rightarrow 2RSO_3H + H_2O + 4SO_2$	S	OK	No	Possible
53	Alkyl Polysulfides	Sulfuric Acid	Physical Solution	Nil		S	Yes	Yes	Probable
54	Alkyl Polysulfides	Sulfuric Acid	Oxidation	Sulfones, etc	Similar to Reaction No. 52	S	OK	No	Probable
55	Elemental Sulfur	Sulfuric Acid	Oxidation[n]	Sulfur Dioxide	$S + 2H_2SO_4 \rightarrow 2H_2O + 2SO_2$	S	OK	No	
56[12]	Elemental Sulfur	Mercaptans and H_2SO_4	Oxidation	Dialkyl Trisulfides	$2RSH + S + H_2SO_4 \rightarrow R_2S_3 + SO_2 + 2H_2O$	G,B,S	No	No	35
57	Carbon Disulfide	Sulfuric Acid	Nil[o]					No	15
58	Thiophenes	Sulfuric Acid	Physical Solution	Nil		S	Yes	Yes	44
59	Thiophenes	Sulfuric Acid	Sulfonation	Thiophene Sulfonic Acids[c]	$C_nH_{2n-6}S + H_2SO_4 \rightarrow C_nH_{2n-7}S.SO_3H + H_2O$	S,B	Yes	Yes	15,32
60[21]	Thiophenes	Olefins	Alkylation	Alkyl Thiophenes	$C_nH_{2n-6}S + C_mH_{2m} \rightarrow C_nH_{2m+1}.\ C_mH_{2n-6}S$	B,S	Yes	Yes	45,46,47
61[24]	Thiophenes	Olefins	Condensation	"Colored Products"		B,S	Yes	No	15,48,49
62[25]	Thiophenes	Aldehydes	Condensation	Resin		S,B	Yes	No	80
63[24]	Thiophenes	Aldehydes in presence of nitrogen salts	Aminomethylation	Thienylamines		S	Yes	No	51,52
			Condensation	Dithienylmethanes		B,S,		Yes	51,52

Reactions That Can Take Place During the Acid Treatment of Gasoline
(CONTINUED)

Reaction No.	Constituent	Reactant	Reaction Type	Product	Equation of Reaction	Destination of Product[a]	Desirability[b]	Significant[c]	References
64	Thiophthenes	Sulfuric Acid	Polymerization	Colored Materials		S,B	Yes	No	49
65	Sulphoxides	Sulfuric Acid	Physical Solution	Nil		S	Yes	No	15,43
66	Sulphones	Sulfuric Acid	Physical Solution	Nil		S	Yes	No	15,43
67	Alkyl Sulfates	Sulfuric Acid	Physical Solution	Nil		S	Yes	Yes	15,43
68	Alkyl Sulfates	Sulfuric Acid	Oxidation	Ketones	$RR'CHSO_4H \rightarrow RCOR' + H_2O + SO_2$ $(RR'CH\text{-})_2SO_4 \rightarrow 2RCOR' + H_2O + SO_2$	S S	No No	No No	
69[19]	Alkyl Sulfates	Olefins	Addition	Dialkyl Sulfate	$C_nH_{2n} + RHSO_4 \rightarrow C_nH_{2n+1}HSO_4$	S,B	No	Yes	15
70[66]	Alkyl Sulfates	Mercaptans	Alkylation	Dialkyl Sulfides	$C_nH_{2n} + RSH \rightarrow C_nH_{2n+1}SR$	G,B	OK[b]	No	46
71	Pyridines	Sulfuric Acid	Salt Formation	Pyridine Sulfate	$C_5H_5N + H_2SO_4 \rightarrow C_5H_5NH.HSO_4$	S	OK	Yes	15,57
72	Alkyl Pyridines	Sulfuric Acid	Oxidation	Pyridine Carboxylic Acids		S	OK	No	53
73[20]	Alkyl Pyridines	Aldehydes and Ketones	Condensation	(β—Hydroxy alkyl) Pyridines		S	OK	No	55,56
				Alkenyl Pyridines		S	OK	No	55,56
74	Pyrroles	Sulfuric Acid	Salt Formation[p]	Pyrrole Sulfates[p]	$C_4H_4N + H_2SO_4 \rightarrow C_4H_4NH.HSO_4$	S	Yes	Yes	44,57
75	Pyrroles	Sulfuric Acid	Polymerization	Pyrrole Polymer		S	Yes	Yes	44,57,58
76	Pyrroles	Aldehydes	Condensation	High M.W. Product		S	Yes	No	59,60
77	Nitriles	Sulfuric Acid	Physical Solution	Nil		S	Yes	No	44,61
78	Nitriles	Dilute Acid	Hydrolysis	Naphthenic Acid	$R.CN + 2H_2O \rightarrow R.CO.ONH_4$	S	OK	No	
79	Naphthenic Acids	Sulfuric Acid	Physical Solution	Nil		S	Yes	Yes	15
80[67]	Naphthenic Acids	Olefins	Esterification	Esters	$R.CO.OH + C_nH_{2n} \rightarrow R.CO.OC_nH_{2n+1}$	S	No	No	12,63
81	Phenols	Sulfuric Acid	Physical Solution	Nil		S	No	Yes	54
82	Phenols	Sulfuric Acid	Sulphonation	Phenol Sulfonic Acids	$C_nH_{2n-7}OH + H_2SO_4 \rightarrow C_nH_{2n-8}OH.SO_3H + H_2O$	S	No	Yes	64
83	Phenols	Sulfuric Acid	Oxidation	"Oxidation Products"		S	No	No	15,68
84[10]	Phenols	Naphthenes	Condensation	"Condensation Products"		S,B	No	No	65
85	Phenols	Olefins	Condensation	"Colored Products"		S,B	No	No	48
86	Phenols	Olefins	Alkylation	Alkyl Phenols	$C_nH_{2n-7}OH + C_mH_{2m} \rightarrow C_mH_{2m-1}C_nH_{2n-8}OH$	S,B	No	Yes	57,66
87	Phenols	Aldehydes	Condensation	Resins		S	No	No	69
88	Aldehydes and Ketones	Sulfuric Acid	Aldol Condensation	Polymers		S	Yes[b]	No	
89[18]	Aldehydes	Aromatics	"Formolite Reaction"	Resins		S	No	No	4,69,73
90[70]	Aldehydes	Olefins	Condensation	Glycols		S	No	No	72,74
91[27]	Aldehydes	Olefins	Condensation	Resins		S	No	No	69,72
92[28]	Aldehydes	1-Alkenes in the presence of acyl peroxides	Condensation	Ketones	$R.CH=CH_2 + R'CHO \rightarrow R.CH_2.CH_2.CO.R'$	S,B	No	No	75
93[52]	Aldehydes	Thiophenes	Condensation	Resins		S	Yes	No	50
94[53]	Aldehydes	Thiophenes in the presence of nitrogen salts	Aminomethylation	Thienylamines	See Reaction No. 63	S	Yes	No	51,52
			Condensation	Dithienylmethanes	See Reaction No. 63	B,S	Yes	No	51,52
95	Aromatic Aldehydes	Higher Alcohols	Condensation	"Colored Products"		S	No	No	76,77
96[71]	Aldehydes & Ketones	Alkyl Pyridines	Condensation	(β—Hydroxyalkyl) Pyrridines	See Reaction No. 73	S	OK	No	55,56
				Alkenyl Pyridines	See Reaction No. 73	S	OK	No	55,56
97[37]	Aldehydes	Phenols	Condensation	Resins		S	No	No	69
98[46]	Aldehydes	Mercaptans	Condensation	Mercaptals	$2RSH + R'CHO \rightarrow R'CH(SR)_2 + H_2O$	S	Yes	No	12
99[47]	Ketones	Mercaptans	Condensation	Mercaptoles	$2RSH + R'_2CO \rightarrow R'_2C(SR)_2 + H_2O$	S	Yes	No	12

FOOTNOTES

[a] Destination of Product. The letters indicate the final destination of the reaction product after treatment as follows: S = to Acid Sludge; R = to Re-Run Bottoms; and G = into the Redistilled Gasoline. A combination of these letters indicates that the reaction product is distributed in decreasing amounts in the order mentioned.

[b] Desirability. NO means that the reaction is undesirable either from the viewpoint of removal of valuable constituents, or from the formation of undesirable materials. OK means that the result of the reaction is not important. YES means that the reaction is one of those normally required of the acid treatment process.

[c] Significant. YES means that the reaction takes place to a significant extent during the treatment under normal operating conditions, while NO means the opposite.

[d] Isoparaffins are more reactive than normal paraffins.

[e] Continuation of this reaction can give rise to poly sulfonic acids.

[f] The intermediate cyclo-di-olefins formed are very reactive and are mostly polymerized. Hence the yield of aromatics from this reaction is very small. Otherwise the reaction would be of value.

[g] Dialkyl sulfates remaining in the gasoline decompose (at 285° F.) to liberate sulfur dioxide on distillation.

[h] This reaction is equivalent to the hydrolysis of the alkyl sulfate but can take place without the intermediate formation of the ester.

[i] Including cycloparaffins or naphthenes.

[j] These materials, part of which can remain in the gasoline, decompose into their progenitors on distillation (at 240° F.).

[k] OK only if the product is sufficiently high boiling to remain in the re-run bottoms.

[l] More particularly cyclo-olefin polymers.

[m] The disproportionation of the diolefin can continue with the formation of tars.

[n] This reaction takes place so slowly that it will occur to a negligible extent during the acid treatment process.

[o] There appears to be no recorded reaction of carbon disulfide that takes place during the acid treatment of gasoline.

[p] Pyrrole is a very weak base so that there is appreciable physical solution in the acid as well.

[q] The reactions are listed under the constituents. A double number indicates that two constituents react and such reactions are tested twice, 32[52] olefines with mercaptans, 43[22] mercaptans with olefines.

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Fractionating Unit Stabilizes Crude Oil Natural Gasoline

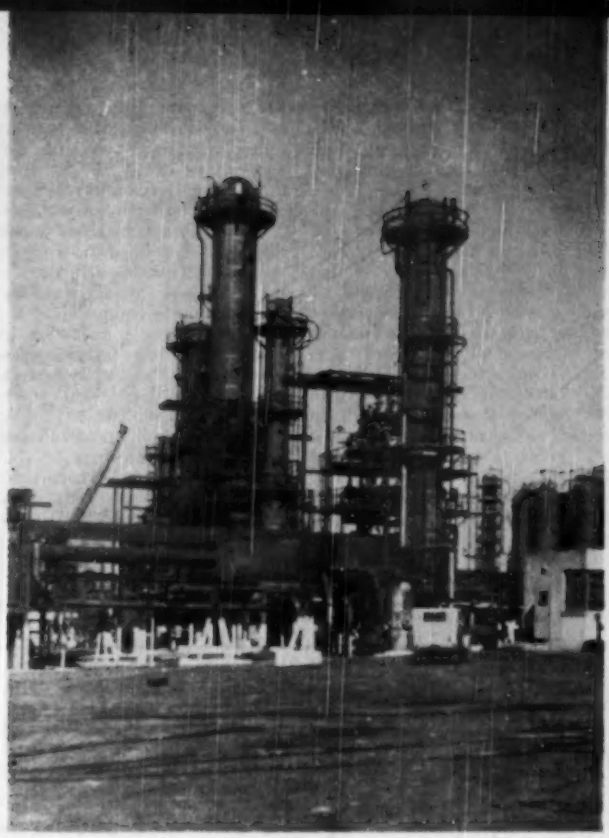


Figure 1. Unit which is used to Fractionate Natural Gasoline from Crude Oil Mixture.

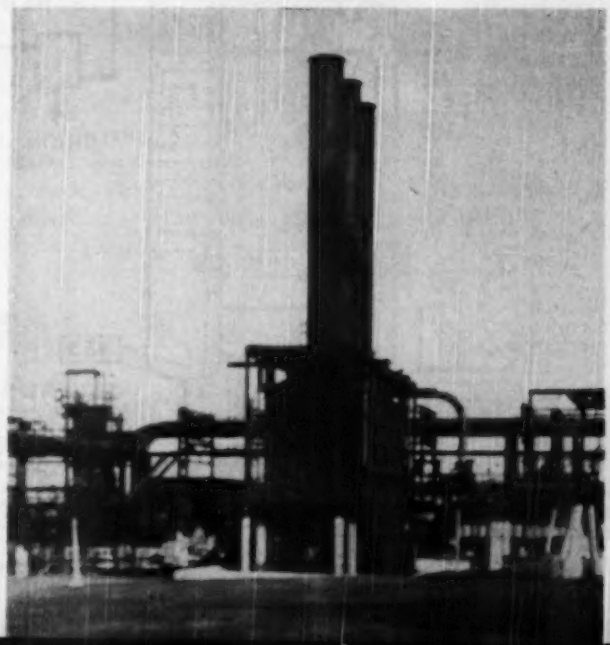
WHEN a single pipe line is used to transport mixtures of crude oil and natural gasoline from the field to the refinery, the problem at the refinery is separation of the mixture to obtain the desired products. To perform this operation efficiently, with the least cost and supervisory attention, the unit shown in Figure 1, has been designed for highly flexible operation. Natural gasoline is separated from the crude oil, and at the same time, the unit stabilizes the crude oil so that subsequent refining is simplified. The unit is designed to operate across a broad range of conditions, because the mixture of crude oil and natural gasoline varies widely in composition. On a basis of field operations, the percentage of natural gasoline mixed with the crude oil ranges as high as 45 percent of the total volume to as low as 25 percent, depending on the number of flowing and pumping wells operated, and the quantity of material from the gasoline plants.

By mixing the two materials, only one pipe line is necessary for transportation, and stabilizers and fractionators are eliminated from the gasoline plants. Only the conventional deethanization of the raw natural gasoline is necessary.

The unit is in the main section of the refinery, and so arranged that it may be operated as a crude stabilizer, or as a technical fractionating unit for producing specialized products from natural gasoline or other low boiling feed stocks. The unit contains a single fractionating column 8 feet in diameter and 72 feet high. It is designed to handle as much as 600 barrels per hour of charge stock having a natural gasoline content as high as 45 percent.

In normal operation, the unit charges 588 barrels per hour of crude oil and natural gasoline mixture, 45

Figure 3. Three-coil Direct-Fired Reboiler Unit Used with the Crude Oil Mixture Fractionator.



percent of which is natural gasoline. This charge is preheated by exchange with the bottoms, then further heated in a stream heated exchanger so that the charge enters the tower at 280° F. on the twelfth tray, as shown in the flow sheet of Figure 2.

To obtain the temperature required for stripping the natural gasoline, and other light fractions in the crude oil, the unit is supplied with a direct-fired reboiler heater, Figure 3. This heater contains three separate cells for three sets of heating tubes. The tubes are arranged for parallel flow of the material. Each cell is heated to a different temperature, ranging from a low of 482° F. to 503° F. An intermediate temperature of 489° F. is maintained in the tubes of the third cell, with the fuel controls arranged so that the outlet line temperature is at 488° F.

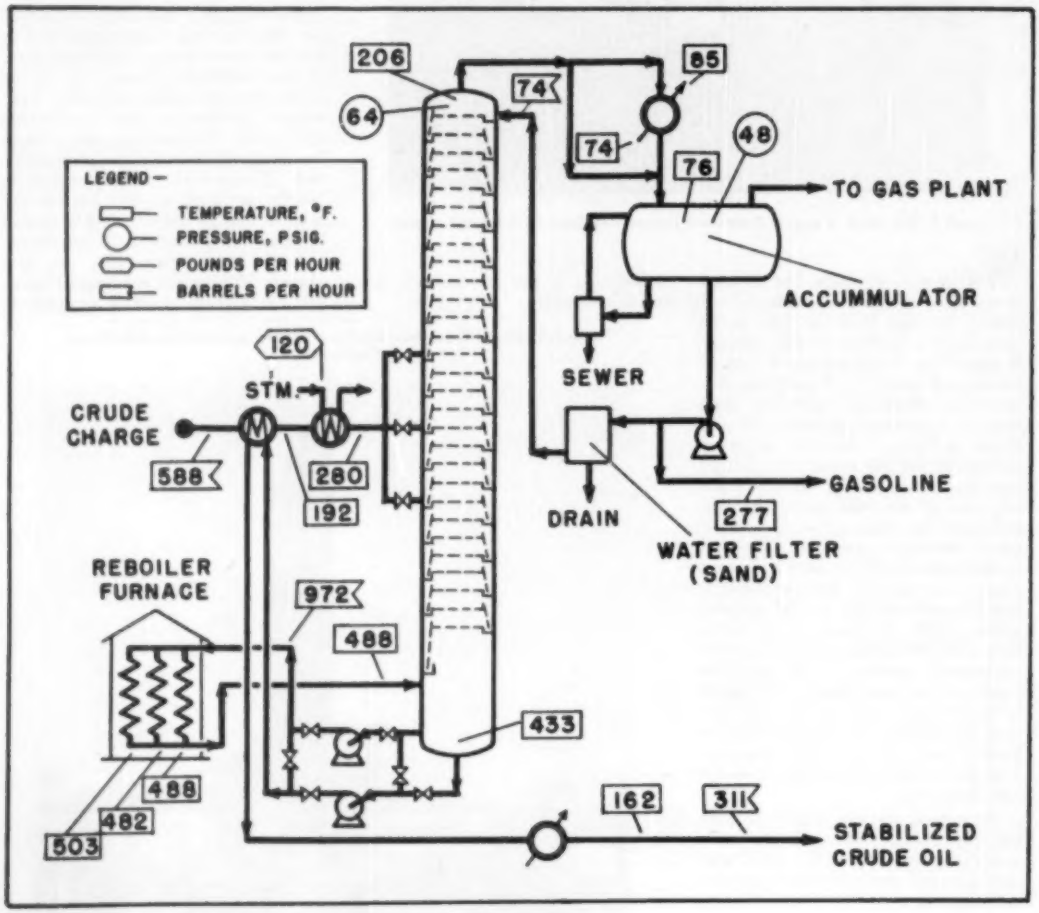
With three separate heating coils operating in parallel, the temperature of the material in the transfer line can be controlled more precisely, than when the entire quantity is circulated through a single set of tubes.

The material withdrawn from the base of the column returns to a point slightly above the point of withdrawal, so that the hot oil, under a column pressure of 64 psig., is stripped of products having higher boiling ranges than the natural gasoline. Bottoms, after exchange with the feed, pass through a single bottoms cooler, containing 720 square feet of surface with water pumped through the shell in quantities sufficient to reduce the stabilized crude to a temperature of 164° F.

Overhead vapors, for all practical purposes, are condensed without vapor loss by a set of four shell and tube overhead condensers, each unit of which contains 1010 square feet of tube surface. These condensers are arranged in pairs. Water at an average temperature of 74° F. is circulated through the overhead condensers to produce a product temperature of 76° F. The steam of reflux is pumped through a sand filled water separating vessel which extracts any water which may be mixed with the gasoline. The reflux pump is equipped with back pressure controls and other instruments, so that the excess gasoline removed from the accumulator above that required for column control is transferred to storage.

If operating conditions and temperatures reach a point where the overhead vapors are not totally condensed, the vapors from the accumulator can be routed to the refinery's vapor recovery system, or to a nearby natural gasoline plant for recovery.

Figure 2. Unit No. 23, Mex-Tex Natural Crude Operation, Borger Refinery, Borger, Texas.



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Among the Revere Condenser Tube Alloys are: Admiralty Metal, Arsenical Copper, Muntz Metal, Aluminum Brass, Aluminum Bronze, Cupro-Nickel. Revere also supplies tube plates in a variety of alloys. If you have any questions regarding the selection of tubes or plates for condensers and heat exchangers, consult Revere.

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others active in the industry.

Energetic Kalichevsky Begins New Series For the Refiner

V. A. KALICHEVSKY, who is known to his friends as "Kali," has been a frequent PR contributor. His current article, "Sweetening and Desulfurization of Light Petroleum Products, Part I," appears on page 97.

Consulting chemical engineer for Magnolia Petroleum Company at its Beaumont, Texas, refinery since 1944, Kalichevsky has an impressive professional record that includes early experience with Union Oil Company as research chemist, a period with Standard Oil Development Company, and between 1931 and 1944, duties with Socony-Vacuum Oil Company as section supervisor and general supervisor of the Research and Development division.

He has been connected with the refining industry since his graduation from California Institute of Technology with a bachelor of science degree in chemical engineering in 1924. The year of his graduation he married Valentina B. Fedorenko. Their one daughter, Kira V., has followed her father's profession in chemistry.

Kalichevsky's books, which include "From Oil Well to Engine" and "The Amazing Petroleum Industry," an American Chemical Society monograph, "Modern Methods of Refining Lubricating Oils," numerous contributions to technical journals and papers written as the result of active participation in the programs of technical societies, have all been well read in the refining industry. His last contribution to PETROLEUM REFINER, "Processing of Lubricating Oils," appeared in the February, 1948, issue.

In addition to his professional duties, his energetic writing, and his ACS activities, Kalichevsky continues to find time for his favorite recreations. Among these are extensive reading, especially of history, a collection of swords, a woodworking shop and chess.

V. A. KALICHEVSKY

A. F. BLUMER

Inspection Head Writes of Welding

A. F. BLUMER, whose article, "Welding Quality Controlled in Petroleum Refinery," appears on page 101, is head of the special inspection section, Equipment Inspection Department of Esso Standard Oil Company's Louisiana division at Baton Rouge. In this capacity, he has been directly associated with welding and welding quality control, his experience in this field qualifies him to write expertly on this subject.

A graduate of Louisiana State University with a bachelor of science degree and a master of science degree in mechanical engineering, he has been affiliated with Stand Oil Development Company and with both the East Coast and the Louisiana divisions of Esso Standard Oil Company. With the latter division, he has spent the last 14 years as metal inspector, maintenance engineer, construction engineer, and mechanical engineer. The last five years of this period, he has spent as group supervisor of corrosion, metallurgical, and welding inspection work and in his present position as head of the special inspection section.

Parten Gives Answers To Questions on PAD

J. R. PARTEN, consultant to Petroleum Administration for Defense, displays much optimism concerning the government and private industry in the interview entitled, "PAD Designed to Protect Industry's Free Competition," which appears on page 92. A Houston oil man and president of Woodley Petroleum Company, he was chosen by President Truman for the job as consultant.

Born at Madisonville, Texas, Parten attended The University of Texas from 1913 to 1917, when he entered the service. At the time of his discharge in 1919, he had been promoted to the rank of major.

He entered the oil business at Shreveport in 1919, and in 1922 was one of the organizers of Woodley Petroleum Company of Delaware. He also played an active part in the organization of Premier Oil Refining Company of Texas in 1935 and was chairman of the board from 1935 to 1948.

His affiliations have included president of Independent Petroleum Association of Texas, 1931-35; member of the Board of Regents of the University of Texas, 1935-41, and chairman of that board, 1939-41; industry representative on Tanker Control Board, Office of Petroleum Coordinator, 1941; member of Petroleum Industry War Council, 1941; director of transportation, Petroleum Administration for War, 1942-43; member of Development Board, The University of Texas, since 1941; chief of staff of American Delegation, Allied Reparations Commission to Europe, 1945; member of National Petroleum Council, by appointment of the Secretary of Interior, since 1946; member of Military Petroleum Advisory Council since 1947 and consultant on petroleum to the Secretary of the Interior, 1950.

He is a member of the American Petroleum Institute, Mid-Continent Oil & Gas Association, Independent Petroleum Association of America, Independent Petroleum Association of Texas, and Texas Independent Producers & Royalty Owners Association.

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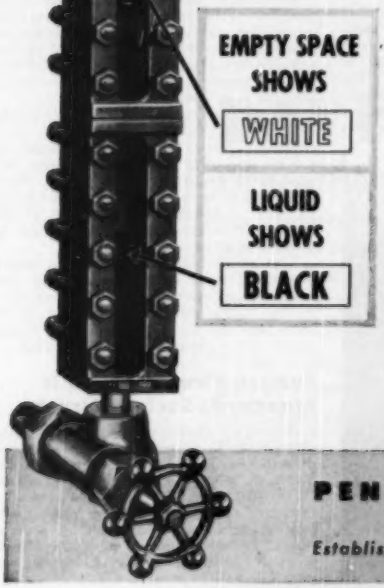

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H. H. DUNKLE

"Gasket" Author Is Square Dance Caller

H. H. DUNKLE, author of "Metallic Gaskets Given Boost by Oil Industry Development" on page 135, has been staff manager of the gasket department of Johns-Manville Sales Corporation of New York since 1947. Prior to that he was employed for seven years as research and design engineer by Goetze Gasket and Packing Company which was purchased by Johns-Manville.

Born in Boston, Dunkle received his bachelor of science degree in metallurgy from Sheffield Scientific School, Yale, and his master of science degree in metallurgy from Yale in 1934. He was then employed by Phelps Dodge Copper Products Corporation of Yonkers, N. J., and Elizabeth, N. J., as research, development and control metallurgist on copper and copper alloy wire, pipe, and tubing.

Dunkle and his wife have four children. His hobbies are home remodeling and square dance calling.

He is a junior member of ASME and a member of ASME "Section on Gaskets," subcommittee on rules for bolted flanged connections.

API President Is Named to World Congress Committee

Frank M. Porter, president of the American Petroleum Institute, has accepted the invitation to be a member of the Committee of Honor for the Third World Petroleum Congress, to be held in The Hague May 28-June 2, 1951.

Of the approximately 300 papers to be presented at the Congress, 215 will be on subjects of interest to men in the refining field. They will cover physical operations in oil processing, oil processes involving chemical conversions, production of chemicals from petroleum, their properties and applications, measurement and control, analysis and testing, utilization of oil products, construction of equipment, transport and storage, and economics, statistics and documentation.

Jennings Gives Ideas For Adequate Defense

B. BREWSTER JENNINGS, president of Socony-Vacuum Oil Company, began his career in the oil industry 30 years ago as clerk in the Marine department of Standard Oil Company of New York. After becoming first purchasing agent and then manager of the Real Estate department, he transferred to Socony-Vacuum in 1931, when it was formed, as assistant to the president, a position he held for 15 years.

During World War II, from January, 1942, to July, 1944, Jennings directed tanker operations for the Maritime Commission and the War Shipping Administration, and was a member of the Petroleum Supply and Distribution Board. On his return to Socony-Vacuum he was elected president and executive committee chairman.

His article, "Adequate Defense Calls for Industry-Military Coordination," appears on page 85.

Jennings attended St. Paul's at Concord, N. H., and is a graduate of Yale University.

Southeastern Secretary Is Appointed by LPG Society

Thomas G. Fields, retired U. S. Marine Corps officer and veteran of two world wars, has been appointed district secretary of the Liquefied Petroleum Gas Association for the new Southeastern district. His office, which will serve Alabama, Florida, Georgia, North Carolina and South Carolina, is at 800 Peachtree Street, Atlanta, Ga.

DOWN-UNDER PAIR—Here is a late snapshot of PR Author, George E. Mapstone and son. Mapstone, whose name is familiar to Petroleum Refiner readers, contributes "The Chemistry of the Acid Treatment of Gasoline" which starts on page 142. He also had an article in last month's issue. Mapstone lives and works in Australia.

E. W. KORSMEYER

Korsmeyers Enjoy Real Estate Projects

E. W. KORSMEYER, secretary of Cities Service Refining Corporation, Lake Charles, La., has participated in the conduct of varied functions of the parent company's auditing staff. His article, "Interpretation of Earnings Changes in an Oil Company" appears on page 109.

Korsmeyer has been with this company or with one of its affiliates for more than 30 years, and has been an officer and/or director of several of the subsidiaries. His present post dates from the inception of Cities Service Refining Company in 1942.

He and his wife, the former Cecile Degnan of Toledo, Ohio, have thre children—Jerry, 19, who is a junior at L.S.U. majoring in physics; Connie, 17, who is a freshman at McNeese State College and is studying art; and Cecile, 13, who is in the eighth grade at St. Charles Academy and is interested in music and dancing.

The family likes to have a real estate project of some kind—the building of a house or the operation of a small farm—in the course of development at most times. As to his personal hobbies, Korsmeyer enjoys hunting and gardening.

Texaco Vice President Is Standards Society Director

American Standards Association has elected R. F. Baker, vice president and director of The Texas Company, New York, as a director of the association. Baker has been in close touch with the standardization of oil field equipment, machinery and supplies, and for several years before coming to New York worked for the company in Oklahoma and Texas.

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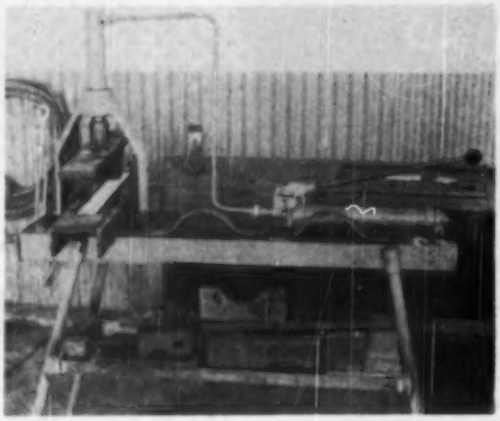
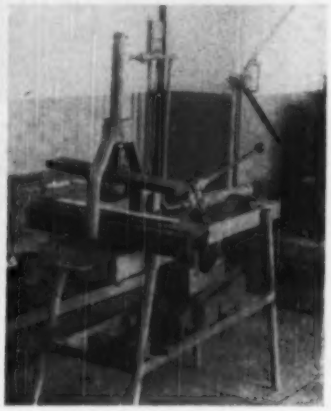
HOW TO DO IT

HOW TO USE—
Weld Tester For Pipe Clamps

A HYDRAULICALLY operated tool, designed and built to test coupons cut from welding beads can be converted by changing dies to make pipe clamps. The original purpose of this press was for a bending test of welded strips and coupons cut from test welds in the shop. The machine has a table fitted with pipe legs set in ferrules welded to the table top. Angle iron cross braces between the legs are placed with the inside of the angle up to retain a sheet metal shelf on which the dies are placed while not in use. The table top is made of heavy sheet metal. A sliding drawer in one end contains small dies and retaining pins, which hold the upper dies to the hydraulic piston. The hydraulic pump at one end of the table has a reservoir cylinder to supply hydraulic fluid to the small pump operated by a long lever. The top die cylinder is mounted vertically on a heavy yoke supported by angle iron strips welded to the table top. The piston in the upper cylinder is fitted with a chuck-type head to hold the top die, which is retained in position for use with a pin. The pin serves only to hold the dead weight of the top die in the chuck-type head. The pressure exerted by the operating cylinder is against the neck of the top die.



The lower die is made to match the upper one, leaving adequate space between them for the strap of steel used



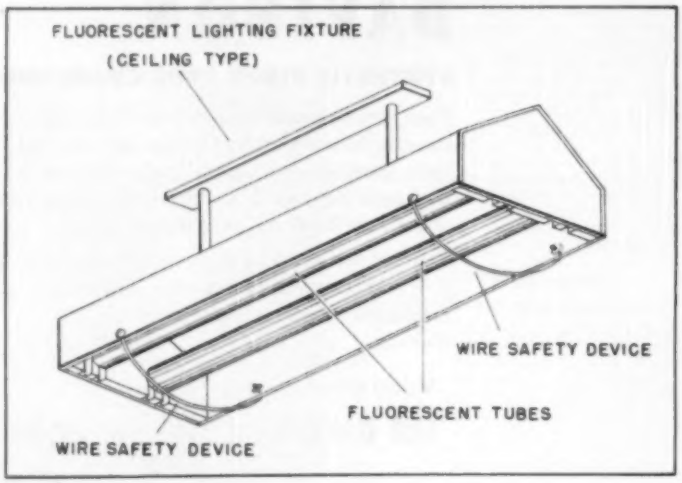
Oil Company, Louisiana Division, Baton Rouge. Suggestion submitted by Chemists M. N. Hale and M. D. Kramer, Esso Laboratories.

HOW TO PROVIDE—
Fluorescent Light Safety Device

IN MANY types of fluorescent light fixtures no provision is made to prevent the tubes from falling and breaking, if they slip from the sockets due to vibration or other causes. Breakage of these tubes is extremely unsatisfactory from a safety standpoint, particularly if the fixture is a ceiling type. Glass fragments from a broken tube would scatter over a wide area and at a rather high velocity, since the tubes are evacuated. The inside surface of each tube is coated with a powder containing zinc beryllium silicate. If the dust from this powder is inhaled, pulmonary granulomatosis may result.

To prevent the tubes from falling from the fixture, a strand of KA_1S wire is bolted at each end of the fixture across the opening beneath the tubes as a guard. The sketch illustrates the method of applying the guards.

Sketch and material courtesy of "Coin Your Ideas" Committee, Esso Standard

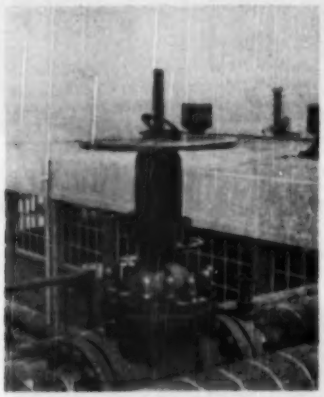


to make the pipe clamp. Both upper and lower halves of the die are wide enough to form various sizes of clamps, but the usual type is the strap iron used for conventional pipe clamps. In operation, the strap steel is cut to the length necessary to form the clamp. When the strip of steel is laid on the lower half of the die, pumping down the top half forms the strap. Bolt holes are then drilled, and the clamp is ready for use. Several different sizes of upper and lower dies are supplied with the machine so clamps from one to six inches can be made quickly. When the machine is used as a tester for welding beads, the coupon is placed between dies following the form of conventional bending testers. The upper die is a rounded nose-type which fits into a block of heavy steel shaped to receive the coupon. The coupon receives a sharp bend at the seam the welder laid on the pipe or piece of flat work.

HOW TO REPAIR—
Steam Valve in Service

STEAM leaking through the bonnet of a high-pressure steam line master valve because of a gasket failure, caused one refinery considerable worry. To make a complete repair, the unit, charging 40,000 barrels daily, must be shut down, resulting in expensive repair.

The repair was made with full volume of steam flowing through the header by the plant welder, as shown in the photograph. Scaffolding was built to provide



a working platform while the mechanic planned his procedure. Cap nuts were obtained for the bonnet bolts, which were loosened one at a time. Then the bolts were removed one at a time and heavy copper ring gaskets were installed under the bolt heads and beneath the cap nuts. When all bolts had been equipped in the manner the welder started his job. He first welded a ½-inch collar to the gate body and bonnet at the contact seam. The closing bead to join the bonnet to the body was started on one side of the collar, and continued along the seam until a continuous bead had been laid on the gate valve. A small nipple and globe valve in the ½-inch collar was then used to divert the flow of steam until the welding was completed. After the welding, the valve was closed.

HOW—
Insulation Collar Prevents Corrosion

ONE of the most difficult problems, in insulation of refinery and gasoline plant process vessels, is the prevention of corrosion behind the insulation on the external surfaces of the vessels. Corrosion is especially difficult to combat in plants in the Gulf Coast area, where condensation of salt-laden moisture from an atmosphere of high humidity is a common occurrence. In addition, heavy rains soak through cracks in the insulation to cause corrosion.

The maintenance department of one Gulf Coast refinery found that their insulation-corrosion problem was around the nozzles in the vessels. Figure 1 illustrates the method in use when the corrosion was found. The insulation tapered in around the nozzle, and the joint between the insulation and vessel wall was sealed. The seal cracked, however, and moisture penetrated to the vessel wall through the crack. Corrosion occurred in the area below the nozzle, immediately beneath the edge of the insulation.

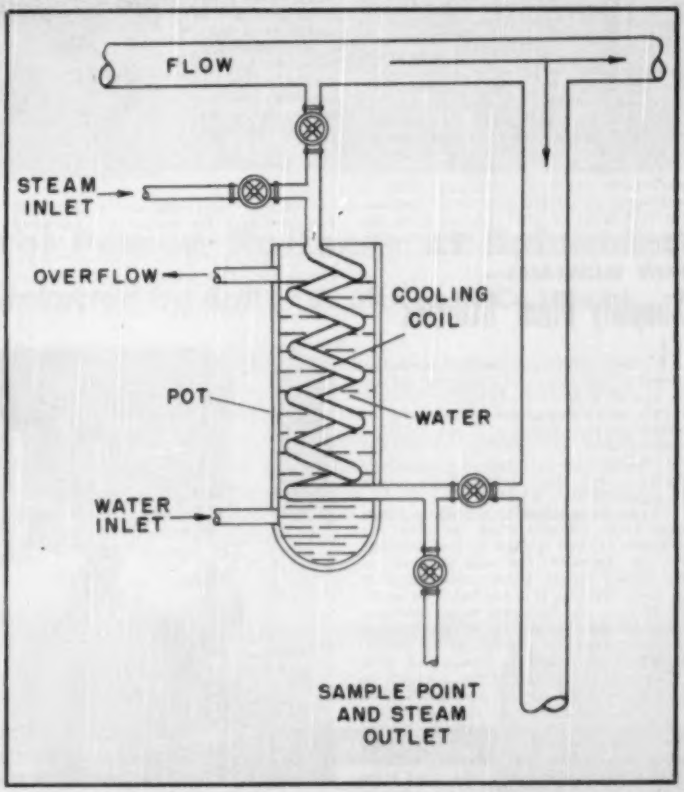
In an effort to remedy the condition, the taper in the insulation around the nozzle was eliminated and the insulation around the nozzle, as shown in Figure 2. Corrosion at the first point was eliminated, but a new corrosion

HOW TO—
Construct Sampler Unit For Hot Pitch Stream

THE sampling unit illustrated in the accompanying sketch is designed for obtaining samples of hot pitch feed to a thermal cracking unit for the laboratory. Hot pitch flows through the cooling coil into the sample container. After the sample has been taken, the inlet valve to the unit is closed, cooling water flow to the pot stopped, and the valve at the sample point opened. Then the steam inlet valve is opened and the coil purged, so that when the next sample is taken from the main line, the sample will be representative of the material flowing at that time, and also the cooling coil will not be plugged or filled with pitch from the last sample.

As shown in the sketch, construction of the sample is quite simple, and it can be made quickly and easily in the refinery welding shop.

Sketch and material courtesy of "Coin Your Ideas" Committee, Esso Standard Oil Company, Louisiana Division, Baton Rouge. Suggestion submitted by Ernest E. Neal, first helper, Number 19 Thermal Cracking Unit.



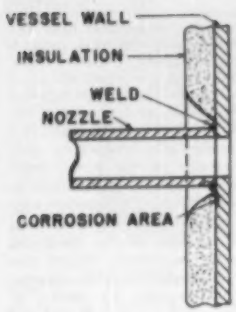


Fig. 1

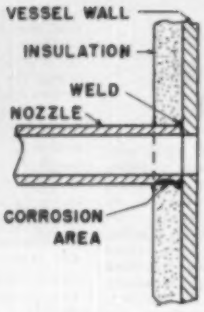


Fig. 2

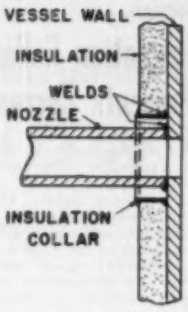


Fig. 3

area was discovered on the lower portion of the nozzle just under the insulation. It appeared that condensation water and rain water, dripping from the underside of the nozzle, penetrated the seal between the nozzle and insulation, and caused the corrosion. The seal around the nozzle could not be made leak-proof.

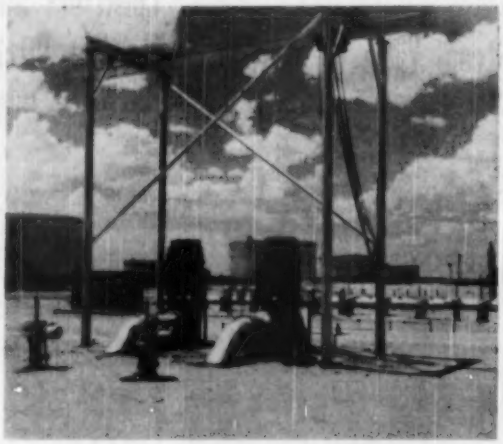
The final and successful method employed is illustrated in Figure 3. An insulation collar is welded to the vessel wall around the nozzle and the insulation sealed to the ring. Since the insulation is sealed at the edge of the collar, it is especially difficult for water to penetrate between the collar and the insulation. On the other hand, in the event that the seal does leak, the corrosion will not damage the vessel wall or the nozzle, but will cause corrosion of the insulation collar, which can be more easily replaced than a nozzle.

HOW TO—
Facilitate Servicing Large Booster Pumps

CONSIDERABLE expense and plant shut-down time is saved through the use of the large servicing crane framework erected permanently over the two large deep-well booster pumps, shown in the picture. The pumps are located in the gravity flow line between storage tanks and the main crude oil pumps.

The large 125-horsepower motors, which drive the 4820-gallons-per-minute pumps, must be removed in order to service or overhaul the pumps. The permanent overhead craneway enables workmen to start work immediately should a breakdown or other service work require removal of the motors.

The framework is designed to provide maximum overhead clearance with a minimum of interference from bracing. Short lengths of steel I-beam span the tops of the pipe corner posts at each end of the framework and a length of I-beam forms the craneway. Overhang of the craneway at either end of the framework permits loading a motor or pump directly aboard a truck backed up to the easily accessible installation.



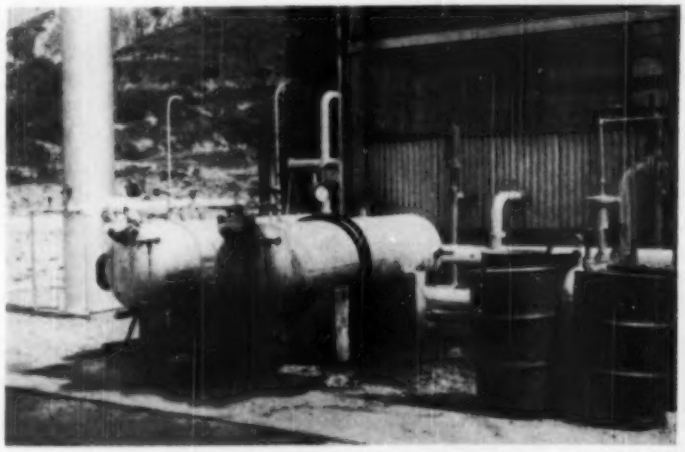
The steel I-beam forming the craneway is equipped with a conventional type of traveling chain hoist. When not in use, the chains are secured to one of the corner posts, out of the way of personnel servicing or inspecting the motors and pumps. When a motor or pump is to be loaded on a truck, it is hoisted clear, then the hoist is moved down the craneway until the motor can be lowered to the truck.

HOW BLOWCASES—
Simplify Plant Utilities

BLOWCASES for distilled water, or steam condensate, and lubricting oil are in use at a booster station for a California gasoline plant. The cases, as shown in the photograph, are made of welded steel, and installed horizontally on concrete piers near the operator's walkway for convenience. Each vessel is equipped with a gauge glass.

Water is supplied to the water blowcase from transportation facilities. Air pressure is then applied to the blowcase so the operator can add makeup to the closed jacket water cooling system at such times at it is needed. The water flows from the blowcase under pressure into the cooling system at the vertical column, shown at the left in the photograph. This vessel is equipped with gauge glasses to permit the operator to check the level of the water.

Oil is transferred to the lubricating oil blowcase from the drums by attaching a low pressure air hose to the small bung connection, and inserting a lance with a threaded fitting to the large bung connection. The pressure applied forces the oil from the drum to the blowcase. After the blowcase is filled, it also is placed under air pressure so that the oil will flow to engine crankcases and other points of use.



New 30,000 Barrel Pemex Refinery at Salamanca

Engineered and Constructed by Arthur G. McKee & Company

LOCATED in an important industrial and agricultural area of the high plateau region of Mexico, this refinery is one of the most beautiful ever built. Sound, thorough engineering is clearly evident in its well-planned, clean-lined arrangement and efficient construction.

The complete refinery is comprised of processing units for Crude Distillation, Thermal Cracking and Catalytic Desulfurization and units for gasoline and kerosene treating and ethyl blending. Power plant, steam plant, water supply system, tankage and extensive shop and maintenance facilities are provided.

With a 30,000-barrel-per-day capacity, this new refinery is designed to produce gasoline, kerosene, diesel oil, other gas oils, liquefied petroleum gas and residual fuel oil.

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Sohio Vice President E. B. McConnell, left, Lima's Mayor, Stanley A. Walker, cutting ribbon to start Sohio's Lima Refinery open house, and President Clyde T. Foster.

The MONTH... in the INDUSTRY

High Honors for Walter Teagle and Others at API Los Angeles Meet

Oil and gas men, representing every phase of the industry, will attend the 30th Annual Meeting of the American Petroleum Institute in Los Angeles, November 13-16. Committee sessions, group meetings, panels and forums will be held in the Biltmore and Ambassador Hotels. Two general sessions at which W. Alton Jones, president of Cities Service Company and chairman of the API board of directors, will preside will be in the Biltmore Theatre.

Teagle

A highlight of the meeting will be the presentation of the Institute's Gold Medal for Distinguished Achievement at a general session on Wednesday morning, November 15. The award will go this year to Walter C. Teagle, former president and chairman of Standard Oil Company (New Jersey).

"Certificates of Appreciation" also are to be presented by the Division of Production, the Research Committee of the board of directors, and the Central Committee on Accident Prevention and Fire Protection.

Teagle will be the fifth recipient of the Institute's gold medal, which was established in 1946 to pay tribute to prominent Americans who have made outstanding contributions to public welfare through the petroleum industry.

Now in his 73rd year, Teagle was the chief executive officer of Standard Oil Company (N. J.) for a quarter of a century beginning with World War I, the period of Standard's greatest growth. He was also one of the charter members and founders of the API in 1919.

In addition to his duties as Jersey Standard executive, Teagle contributed his services generously whenever the government needed him. He organized the Share-the-Work program for President Hoover. He headed the National Industrial Advisory Board, and was a member of the National Defense Mediation Board and the National War Labor Board, among other assignments.

Those who have received the award in the past are J. Howard Pew, director and former president of Sun Oil Company; Dr. Charles F. Kettering, internationally-famous scientist; Dr. William Burton, former president of Standard Oil Company (Indiana), and the late Henry Ford.

Nine "Certificates of Appreciation, including two posthumous honors, will be awarded by the Division of Production.

They will be presented to O. D. Donnell, former president and general manager of The Ohio Oil Company, Findlay, Ohio; Walter Samans, formerly with Sun Oil Company, Philadelphia; C. P. Dimit, vice president, Production department, Phillips Petroleum Company, Bartlesville, Okla.; John A. Ritter, Sun Oil Company, Dallas; J. C. Siegle, Youngstown Sheet & Tube Company, Youngstown, Ohio; Paul D. Torrey, president of Lynes, Inc., Houston; and D. L. Trax, Gulf Oil Corporation, Tulsa.

The posthumous awards will be made to George S. Bays, formerly with Stanolind Oil & Gas Company, Tulsa, and J. Jay Dunn of Ellwood City, Pa., formerly with National Tube Company.

The Research Committee of API's board of directors will present Certificates of Appreciation to Dr. J. Bennett Hill of Sun Oil Company, Marcus Hook, Pa., and Earl G. Gaylord of California Research Corporation, San Francisco. Both awards will be made before the Division of Refining group session on Wednesday, November 15.

The Central Committee on Accident Prevention and Fire Protection will present a Certificate of Appreciation to Max B. Anfenger. The committee awarded such certificates to Emil J. Senne and Clyde W. Smith at the recent National Safety Congress in Chicago.

Anfenger, retired, formerly with Standard Oil Company of California, will receive the honor on the basis of his accomplishments in the development of improved fire-protection techniques and in the protection of the industry against unreasonably restrictive regulations.

Senne, retired, formerly with Socony-Vacuum Oil Company of New York, rendered services in organization of the Institute's accident prevention department and committees. Smith, retired, formerly with Standard Oil Company (Indiana), Chicago, has given 14 years of consistent and valuable aid in the establishment and development of the Institute's safety services.

Imperial Plans Expansion Of Refinery at Edmonton

Construction is scheduled to get under way late this year on the $5 million expansion program at the Edmonton, Alberta, refinery of Imperial Oil, Ltd. Plans call for erection of a fluid catalytic cracking unit and a vacuum pipe still, the program to be completed in about nine months.

Present output of the refinery, about 20,000 barrels a day, will not be increased by the new units but higher quality products will result, officials said.

Sohio Holds Open House At Refinery Dedication

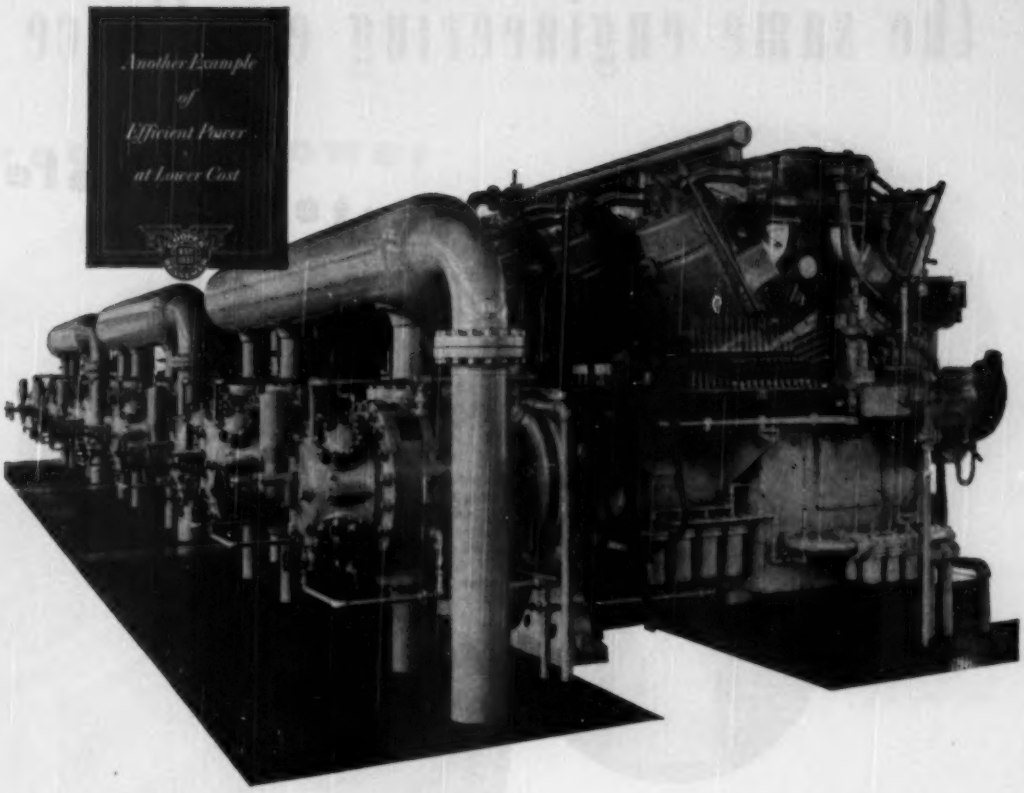
Marking completion and formal dedication of its $33 million modernization and expansion program at the Lima, Ohio, refinery, The Standard Oil Company (Ohio) held open house for the public, with conducted tours through the plant. (See photo at left.)

Top officials of the company were presented with special brass hats by Seward R. Bolles, manager of the Lima refinery. Present for the ceremonies were Clyde T. Foster, president; A. A. Stambaugh, senior vice president; E. B. McConnell, vice president in charge of manufacturing; E. D. Wallace, vice president in charge of production; A. E. Wolf, vice president in charge of finance; J. F. Wilson, vice president in charge of crude oil purchasing; S. H. Elliott, vice president and general sales manager; R. C. Sauer, vice president in charge of supply and distribution; and H. L. Patch, vice president in charge of accounting.

Improvements to the 450-acre Lima refinery were part of the $100 million program carried out by The Standard Oil Company (Ohio) over a three-year period.

Hudson to Build Oil and Gas Processing Plant in Chile

Hudson Engineering Corporation, Houston, has been engaged by the Chilean government to build a $3 million oil and gas processing plant south of the Straits of Magellan on the island of Tierra del Fuego, almost 80 miles south



How to trade engine heat for cold cash!

IF you're a technical man, you know that an engine simply converts the heat of fuel combustion into usable motion or power. You also know that there's always unused heat that must be dissipated or somehow disposed of. In sizeable engine installations this can be a big problem, involving lots of costly cooling equipment and valuable space.

Here again, recent Cooper-Bessemer developments are saving money. For example, hundreds of big engines like the Cooper-Bessemers shown above are used to drive compressors on cross-country pipe lines. Because of the Cooper-Bessemer Turboflow and supercharging developments and other advancements, much more combustion heat can now go to produce power, leaving much less waste heat to be dissipated. Thus the cost of cooling equipment, piping and installation can now be reduced by thousands of dollars. It's a huge plus saving over and above the gains of greater fuel economy and increased power.

Far-reaching developments like these are constantly being worked out at Cooper-Bessemer. And they're being applied to heavy duty engines for *all* services . . . stationary power, locomotive, marine and other mobile uses. If you have a stake in power, be sure to find out about the new things being done by one of America's *oldest* engine builders.

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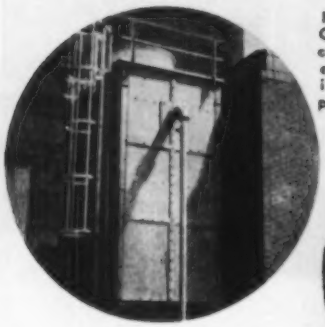


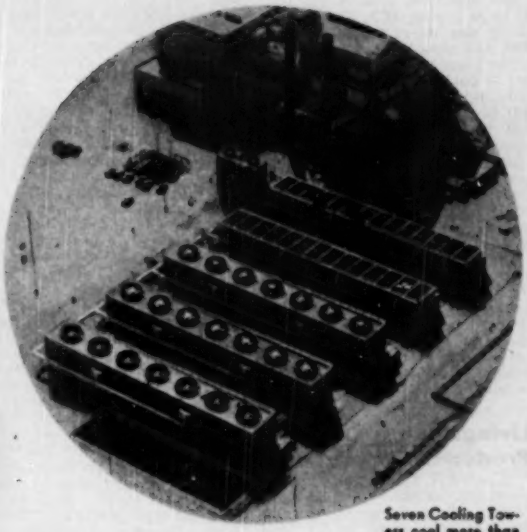
"Package" type Cooling Tower on department store roof, cools 300 gallons of water per minute.

Induced-draft 1-cell Cooling Tower, which cools 5,000 gallons of water per minute in food processing plant, blends with landscape.

FOSTER WHEELER CORPORATION 165 BROADWAY

cooling tower

Induced-draft 6-cell Cooling Tower in oil refinery cools 10,300 gallons of water per minute.



Seven Cooling Towers cool more than 180,000 gallons of water per minute in large power plant.

. . . TO THE LARGEST

Whatever the application—a "package" type on a department store roof in New York City, a twenty-cell tower for a power plant in Arkansas, or a large unit for a chemical plant in India, Foster Wheeler Cooling Towers can be depended on to deliver full capacity in year-round service.

A Foster Wheeler Cooling Tower is your best guarantee of a constant supply of cooling water for steam power plants, processing, air conditioning, or other uses. Regardless of size, the same engineering and construction excellence, the same attention to detail and the same quality of materials go into every Foster Wheeler installation.

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The MONTH...

of Punt Arenas, the southernmost city in the world.

The plant will process gas and crude oil from Spring Hill, Chile's first field, which was discovered in December, 1945, and now has 40 wells.

The plant will process 30 million cubic feet of gas and 6000 barrels of crude oil daily. Butane and heavier hydrocarbons will be extracted and the stripped gas will be returned to the reservoir to minimize pressure decline. The light fractions which, through evaporation, would cause crude oil loss during tanker transportation will be stripped from the crude oil, and the stable liquid hydrocarbons extracted from the gas will be blended with the stripped crude.

The Hudson company has been engaged by Corporacion de Fomento de la Produccion, a division of the Chilean government, to develop process and mechanical design of the plant, to assist in the purchase of equipment, and to supervise the construction at Tierra del Fuego. It is expected that the plant will be placed in operation in June, 1951.

Livingstone Is On DPA Steel Products Advisory Committe

Edward A. Livingstone, vice president in charge of sales of The Babcock & Wilcox Tube Company, Beaver Falls, Pa., has been named to the Steel Products Industry Advisory Committee to advise in the administration of the Defense Production Act as it affects the iron and steel industry. The committee was established by the National Production Authority, Commerce Department.

$2 Billion for Fifth Straight Year Is Domestic Oil Industry's Record

For the fifth consecutive year, the domestic petroleum industry has scheduled the investment of more than $2 billion for development, modernization and expansion of its facilities in this country. This is equal to $14.50 for every man, woman and child in the U. S.

On the basis of a survey, Frank M. Porter, API president, last month estimated capital expenditures of the nation's oil companies during 1950 at $2.4 billion. Of this, all but $228 million is earmarked for domestic facilities.

The $2.172 billion in 1950 raises the industry's postwar domestic investment total (1946 through 1950) to an estimated $10 billion. If American expenditures overseas are counted in also, the over-all total exceeds $12 billion.

The domestic capital expenditure scheduled during the current year is only slightly less than the record-breaking outlay of $2.3 billion made by the industry in 1948 to meet increased public demand for its products and services.

"The high level of investments maintained by the oil industry during the post-war years has brought the nation's ability to produce and manufacture gasoline, fuel oil and other petroleum products to their highest point in history," Porter declared. "While this indicates that the oil industry is better prepared now than ever before to meet military and essential civilian demands, it must be recognized that military requirements fluctuate from day to day, and that unpredictable international events can change this picture rapidly. Adequate peacetime transportation for example, does not necessarily mean adequate wartime transportation."

Porter also noted that the oil industry, as it has done historically, is generating the major part of its financial requirements from its own operations by plowing back its earnings.

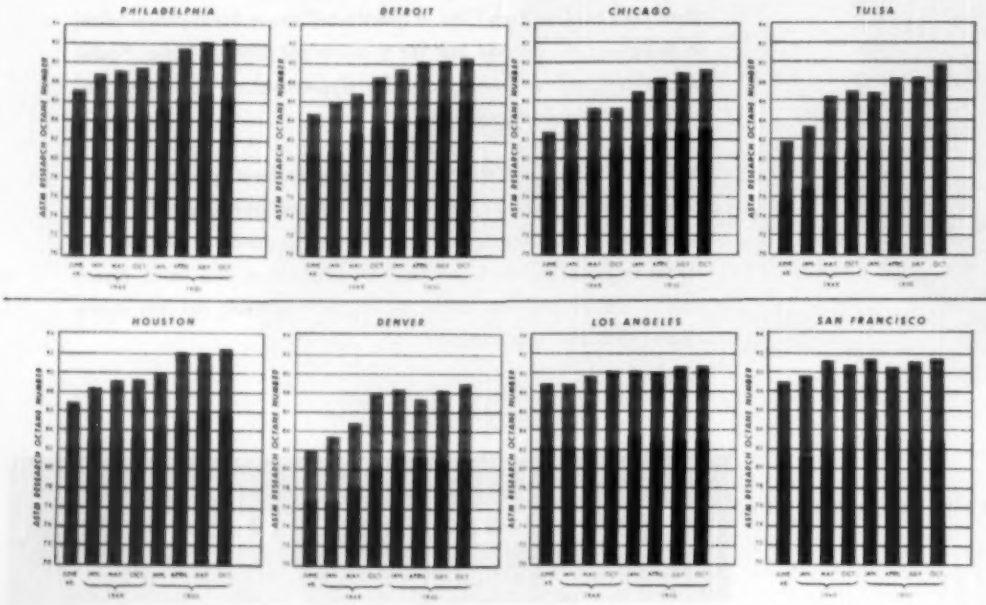
As in past years, the expenditure for production operations—searching for and developing necessary oil and natural gas reserves and supplies—will account for more than half of the capital outlay. In 1950, approximately $1.36 billion will be spent in this branch of the industry, compared to $1.457 billion in 1949 and a 1946-1949 average of $1.341 billion.

These production figures include natural gasoline plant figure expenditures as follows: estimate for 1950, $74 million; actual 1949, $104 million; yearly average 1946-49, $66 million. The last figure compares with a $15 million yearly average for 1936-40.

Investments for refinery facilities in 1950 will be close to $394 million, much of the money going into the latest type cracking plants for producing vital high quality products for domestic requirements and possible military needs.

Transportation estimates total $324 million, the major portion of which is scheduled for pipe line construction work, as follows: crude oil lines, $120 million; product lines, $74 million, and natural gas lines, $91 million. The outlays planned for natural gas lines by the

UPWARD TREND—The motor gasoline survey conducted each quarter by Petroleum Chemicals Division of E. I. du Pont de Nemours & Company, Inc., Wilmington, Del., shows a continuing upward trend in the octane number of both premium and regular gasolines. The record in eight American cities is shown in the charts above.



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The MONTH...

oil industry in 1950 contrast with expenditures of $49 million in 1949 and a 1946-1949 average of $41 million annually. Product pipe line expenditures likewise are increased sharply from the $31 million invested in 1949 and the four-year average of $41 million a year.

The industry's efforts to modernize, improve and expand its marketing facilities—the segment of the industry closest to the public—are expected to result in a record-high capital investment of $281 million in that field. This compares with $233 million spent in 1949 and an annual average of $247 million over the 1946-1949 period.

3-to-1 Ratio

In the five-year period, 1936 through 1940, the industry's capital investments totaled $4.083 billion and averaged $817 million annually. Based on the estimates of 1950 expenditures, the outlay over the 1946-1950 period will total $12.171 billion and average $2.434 a year.

The same 3-to-1 ratio between expenditures generally exists for the various branches of the industry in the two periods.

In a recent statement, the API president pointed out that as a result of the unprecedented industry expansion in postwar years, the oil industry's crude production capacity has been increased 27 percent, its refining capacity 21 percent, and the nation's proved crude oil reserves 24 percent.

FIFTH ANNUAL INSTRUMENTATION SYMPOSIUM ATTRACTS 300

Speakers at the Fifth Annual Symposium on Instrumentation for the Process Industries, October 11, 12, and 13, at College Station, Texas, were: (l-r) Dr. B. W. Thomas, Humble Oil & Refining Company, Baytown, Texas, "Continuous Analysis"; Homer C. Givens, La Gloria Corporation, Falfurrias, Texas, "Speed Control and Synchronization of Multi-Unit Gas or Diesel Engine Plants"; R. E. Claridge, Taylor Instrument Company, Rochester, N. Y., "Improved Pneumatic Control System"; W. T. Marchment, Evershed & Vignoles, Ltd., Chiswick, London, England, "Some Developments in Electronic Instrumentation, Including Process Control"; A. V. Novak, E. I. du Pont and Company, Orange, Texas, "Graphic Panels"; Porter Hart, Dow Chemical Company, Freeport, Texas, (co-author) "Instrumentation of an Ammonia Plant"; R. A. Rockwell, Mason-Neilan Regulator Company, Boston, Mass., "Unbalanced Values Acting on Control Valve Plugs and Their Influence on Diaphragm Motor Design," and R. C. King, Dow Chemical Company, Freeport, co-author of "Instrumentation of an Ammonia Plant." Guest speaker at the Symposium was R. J. S. Pigott, Gulf Research and Development Corporation, and president of the Instrument Society of America.

The symposium is conducted each year by the School of Engineering, Department of Chemical Engineering of A. & M. College of Texas. In conjunction with the symposium, a large exhibit by instrument manufacturers is held also. Registration for the symposium was approximately 300.

Steering committee for the 1950 symposium included M. K. Andersen, Carbide and Carbon Chemicals Corporation, Texas City, Texas; G. L. Farrar, chairman and director of the symposium, A. & M. College; W. H. Fortney, Humble Oil & Refining Company, Baytown; H. C. Givens, La Gloria Corporation; R. E. Hanson, Leeds & Northrup Company, Houston; E. D. Mattix, Cities Service Refining Corporation, Lake Charles, La.; R. E. O'Neill, Industrial Scientific, Inc., Houston; L. W. Parten, The Foxboro Company, Houston; and W. B. Rawson, Maintenance Engineering Corporation, Houston.

Revised SAE Classification Eliminates Two Oil Grades

Two motor oil grades are eliminated in the newly revised SAE Crankcase Oil Classification which provides oils for a wider operating range than its predecessor, according to the Society of Automotive Engineers.

As shown in the accompanying table, grades 60 and 70 have been eliminated. They were dropped because of their extremely limited use, SAE spokesmen said.

Another significant change was the addition of the 5W classification. The 5W oils are considered desirable for subzero operation, particularly cold starting. The studies, which were conducted by the SAE Fuels and Lubricants Technical Committee, revealed that using 5W instead of 10W oil brings a 33 percent average increase in cranking speed. Satisfactory viscosity stability, oil consumption and wear resistance are also properties of 5W oils.

Winter grade oils, 10W and 20W, now a part of the SAE crankcase oil classification, previously were not included.

Viscosities are specified in the revised classification at temperatures more nearly those at which the oils operate. Winter grade viscosities are given at 0° F., and others at 210° F.

Table 1
Revised SAE Crankcase Oil Classification

SAE Viscosity Number	VISCOSITY RANGE			
	S.U.S. at 0° F.		S.U.S. at 210° F.	
	Minimum	Maximum	Minimum	Maximum
5W	6,000 (Note A) 12,000 (Note B)	6,000 Less than 12,000 48,000	....	....
10W				
20W				
20	.....	.....	45	Less than 58
30	.....	.....	58	Less than 70
40	.....	.....	70	Less than 85
50	.....	.....	85	110

Note A: Minimum viscosity at 0° F. can be waived provided viscosity at 210° F. is not below 40 Saybolt Seconds Universal.
Note B: Minimum viscosity at 0° F. can be waived provided viscosity at 210° F. is not below 45 Saybolt Seconds Universal.

Table 2
Former SAE Crankcase Oil Classification

SAE Viscosity Number	VISCOSITY RANGE			
	S.U.S. at 130° F.		S.U.S. at 210° F.	
	Minimum	Maximum	Minimum	Maximum
10	90	Less than 120	.....	.....
20	120	Less than 185	.....	.....
30	185	Less than 255	.....	.....
40	255	.....	.....	Less than 80
50	.....	.....	80	Less than 105
60	.....	.....	105	Less than 125
70	.....	.....	125	Less than 150

Statistics Bureau Requests Refining Wage Information

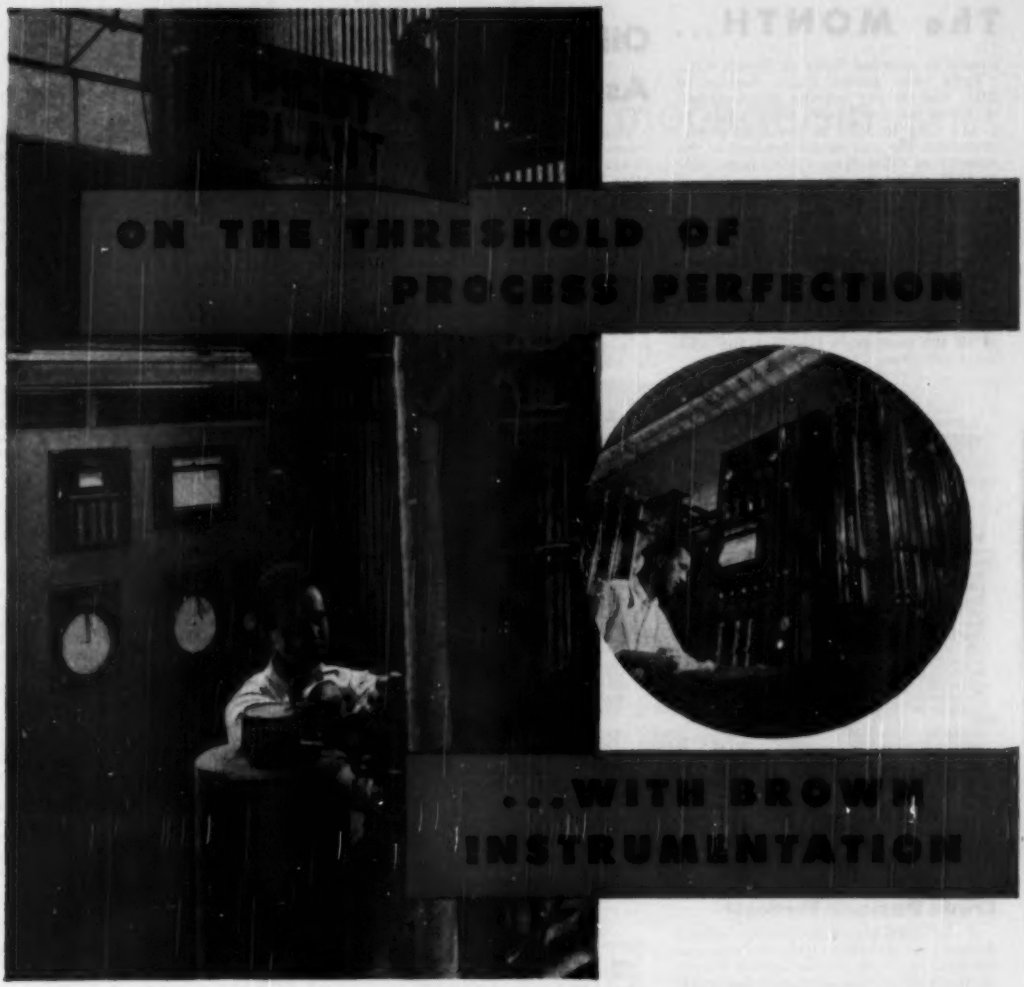
A minimum wage under the Walsh-Healey Public Contracts Act will be set up on the basis of results of an oil refining wage questionnaire sent to every U. S. refiner by the Department of Labor.

Refiners handling government orders of more than $10,000 will be covered by the minimum wage, which will probably be established about the first of 1951.

An official of the Bureau of Labor Statistics called "unfounded" the fears of some refiners that the scope of the wage survey might tend to raise established minimum wage rates. The Bureau believes that the "true picture" of the industry's wages can be obtained only by a survey of rates up to the average, rather than to restrict it to the common labor rate.

Manager for New Plant Named by Cities Service

Don V. Eells of Ponca City, Okla., has been appointed manager of the new terminal and compound plant of Cities Service Oil Company (Del.) at Chicago. S. R. McMurry, formerly foreman of cracking operations at the company's East Chicago, Ind., refinery, has been



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named to succeed Eells at Ponca City.

Eells, who joined Cities Service in 1917, was on the refining division staff at Tulsa for five years, transferring to Ponca City in 1925 as assistant superintendent. He was superintendent of the refinery at Okmulgee, Okla., from 1927 to 1938, when he was transferred back to Ponca City. He was appointed refinery manager in 1942.

McMurry was first employed by the company at Gainesville, Texas, in 1924. In 1930, he was transferred to the Cities Service refinery at East Chicago, and last year upon completion of the $20 million modernization and expansion program there, he was placed in charge of all the company's cracking and affiliated activities.

Oil Industry Leaders In Capital As Defense Measures are Organized

The Petroleum Administration for Defense has inaugurated a program aimed at speeding up, by abnormal means, aviation gas production by an average of 25,000 barrels per day for the remainder of the year. Secretary of Interior Oscar L. Chapman, in launching the program, gave his assurance that he would "use his best efforts" to obtain compensation from the government for the extra costs to refiners involved.

Hugh A. Stewart, acting deputy administrator, asked all producers of avgas to notify him of the quantities of avgas of 100/120 grade or higher, or of components, in excess of their present commitments, they will offer for military purposes.

A. P. Frame, vice president of Cities Service Company appointed avgas program director by Chapman, has emphasized that industry is asked to join the avgas boost, simply on the basis of assurance that Chapman will attempt to get compensations for their expense.

Both he and J. R. Parten, president of Woodley Petroleum Company, consultant to Chapman, pointed out that this is only the first of several increments in avgas requirements.

Stewart has estimated that the amount of the cost to the refiners of this program to total around $4 million. As a result of a similar program during World War II, refiners recovered approximately $1.26 million from the U. S.

PAD has booked the services of Thomas L. Apjohn, Socony-Vacuum Oil Company, as assistant director of the program, and the service of Donald P. Heath, also of Socony-Vacuum.

Consultants to Frame will be Wayne Warren of Humble Oil & Refining Company, Bruce Dunbar of Shell Oil Company, David Neal of Phillips Petroleum Company and Walter Huffman of the Sun Oil Company. The four men have been serving as members of the avfuels blending committee of Military Petroleum Advisory Board's refining panel.

PAD expects eventually to create industrial-technical committees to take over all functions of the Military Petroleum Advisory Board. Such plans were cutlined in a letter from Stewart to Bruce K. Brown, MPAB chairman, who is slated to become deputy petroleum administrator. Brown, president of Pan-American Southern Corporation (Standard Oil Company, Indiana, subsidiary)

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1949:									
January 29	5,493	5,490	258,459	17,531	114,677	7,547	63,142	8,178	63,333
February 26	5,401	5,412	261,965	17,621	124,382	7,430	54,006	8,235	59,348
March 26	5,188	5,353	266,806	17,417	128,067	6,167	48,721	8,305	56,792
April 30	4,980	5,273	271,255	17,969	124,787	6,681	49,989	8,185	60,176
May 28	4,951	5,297	275,190	18,374	120,661	8,943	55,971	8,144	63,758
June 25	4,944	5,222	274,114	18,462	115,715	8,148	63,049	7,856	66,148
July 30	4,731	5,187	271,999	18,068	109,964	6,393	70,767	7,206	67,198
August 27	4,709	5,215	266,455	18,180	106,280	6,491	74,718	7,597	68,394
September 24	4,933	5,377	259,189	18,152	103,262	6,555	81,414	7,419	68,143
October 29	5,075	5,500	252,069	19,002	103,915	7,010	90,358	7,754	66,459
November 26	5,192	5,331	256,400	18,204	104,917	6,971	91,796	8,104	67,067
December 24	4,955	5,482	256,820	18,045	110,164	7,335	78,662	8,046	61,647
1950:									
January 28	4,956	5,470	248,411	18,363	124,270	7,302	66,337	8,389	57,096
February 25	5,000	5,277	245,586	17,703	133,558	6,890	56,050	7,955	48,663
March 25	4,848	5,460	244,227	17,839	135,406	6,870	40,577	8,171	42,546
April 29	5,014	5,314	244,744	18,038	128,655	6,531	36,686	7,272	39,260
May 27	5,116	5,591	240,842	18,704	122,787	7,201	40,607	7,421	39,308
June 24	5,355	5,636	240,762	19,626	115,036	6,958	50,580	7,461	41,291
July 29	5,522	5,870	240,236	19,981	109,076	7,266	61,437	7,870	42,253
August 26	5,599	6,197	236,974	20,263	105,793	7,556	68,841	8,543	41,697
September 30	5,903	6,051	241,631	19,024	104,383	8,460	78,734	8,306	42,330
October 28	5,895	6,051	244,805	19,878	105,062	8,259	84,057	8,449	44,310

Crude Demand Forecast

A 5,670,000-barrel November market demand for domestic crude oil (new production) has been forecast by the Bureau of Mines. The Bureau reports that maintenance of refinery runs "at or below current levels should meet total demand" during the winter months and that the stock situation "seems satisfactory."

Ashland Promotes Wells

Ashland Oil & Refining Company has promoted Everett F. Wells from vice president of sales to executive vice president. Wells became the company's first salesman in 1926.

Three Named to Represent U. S. on World Oil Council

F. S. Clulow of Shell Oil Company; K. G. MacKenzie of The Texas Company, and E. V. Murphree of Standard Oil Development Company, have been chosen by API President Frank M. Porter to represent American oil industry on the Permanent Council of World Petroleum Congress until Dec. 31, 1951.

Third World Petroleum Congress will be held at The Hague, Netherlands, next May 28-June 6.

THE OIL MAN'S CALENDAR

1950	
NOV. 11–13	**Oil Industry Information Committee, Los Angeles, Biltmore Hotel.**
13–16	**American Petroleum Institute, 30th Annual Meeting, Los Angeles, Biltmore and Ambassador Hotels.**
26 to Dec. 1	**American Society of Mechanical Engineers, New York, Hotel Statler.**
27 to Dec. 2	**American Society of Mechanical Engineers, 19th Exposition of Power and Mechanical Engineering, New York, Grand Central Palace.**
3– 5	**American Institute of Chemical Engineers, Annual Meeting, Columbus, Ohio, Neil House and Deshler-Wallick Hotels.**
26–31	**American Association for the Advancement of Science, Annual Meeting, Cleveland, Hotel Statler.**
1951	
JAN. 9–12	**Society of Automotive Engineers, Annual Meeting and Engineering Display, Detroit, Hotel Book-Cadillac.**
15–18	**Plant Maintenance Show, Cleveland.**
26–27	**Instrument Society of America, New York Section, General Meeting "Process Control," New York City, Hotel New Yorker.**
MAR. 5– 7	**Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, William Penn Hotel.**
1951	
MAR. 5– 9	**American Society for Testing Materials, Spring Meeting and Committee Week, Cincinnati, Ohio.**
12–16	**The Instituto Sudamericano del Petroleo, First Southamerican Oil Congress, Montevideo, Uruguay.**
13–17	**National Association of Corrosion Engineers, Annual Conference and Exhibition, New York, Statler Hotel.**
APRIL 1– 3	**Western Petroleum Refiners Association, Annual Meeting San Antonio.**
16–18	**American Society of Lubrication Engineers, Annual Convention and Lubrication Show, Philadelphia, Bellevue-Stratford Hotel.**
18–20	**National Petroleum Association, Cleveland, Ohio, Hotel Cleveland.**
25–27	**Natural Gasoline Association of America, Annual Meeting, Tulsa, Mayo Hotel.**
30 to May 3	**American Petroleum Institute, Division of Refining, Midyear Meeting, Tulsa, Mayo Hotel.**
MAY 28 June 6	**Third World Petroleum Congress, The Hague-Scheveningen, Netherlands.**
JUNE 18–22	**American Society for Testing Materials, Annual Meeting, Atlantic City, N. J.**

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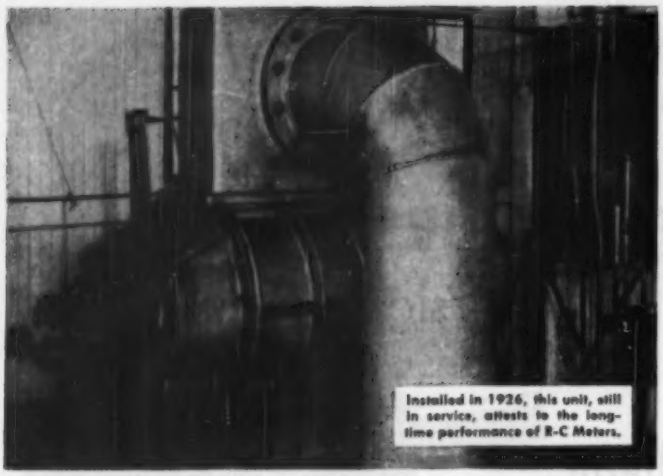
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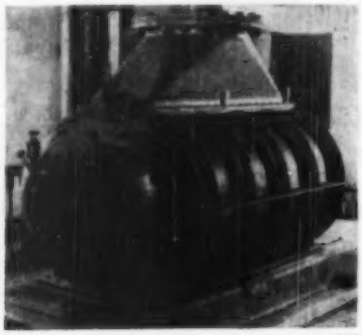
(Below) Typical small capacity R-C Meter for low and medium pressures.



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ONE OF THE DRESSER INDUSTRIES

The MONTH...

has been indorsed for the position by a special committee of NPC.

Until the transition of function to PAD occurs, however, MPAB will continue as before.

The industry personnel already skilled in MPAB work will be utilized in establishing committees which "may be regarded as counterparts of the Military Petroleum Advisory Board's present committee." These committees will be responsible solely to the PAD.

Established as an independent agency by formal order from Chapman, PAD will run the oil and gas phase of the defense program. The deputy administrator will be responsible to the Secretary of Interior.

J. Howard Marshall, president of Ashland Oil and Refining Company, will be a special consultant to Chapman, working with Parten.

The deputy administrator will exercise all the authority of the Secretary with the exception of interceding with the Attorney General for antitrust clearance of PAD programs requiring concerted industry action, of redelegating his own responsibilities without approval, and of establishing industry-wide committees.

Avgas Requirements Less But Capacity Boost Urged

Even though the demand for aviation gasoline in the first half of 1951 will be less than during the current half-year, industry still fails by 26 percent to meet the needs for this product, according to October figures released by Armed Services Petroleum Purchasing Agency.

Government figures show that demand for all grades—except JP-3 jet fuel—was down in varying degrees. Using the periods July-December, 1950, and January-June, 1951, for comparison, requirements for all grades of avgas were off 884,000 barrels. Comparative totals showed a demand of 24,582,000 barrels in the earlier period, and 23,698,000 barrels for the first half of 1951.

Requirements for 115/145 avgas, the highest grade, are down 14,000 barrels to 8,598,000 barrels, while those for grade 100/130 are down 299,000 to 8,525,000 barrels.

Demand for JP-3 will be almost double the current rate as the Air Force intensifies its shift to this easier-to-meet specification, the Purchasing Agency reported.

Rubber Plant Activated By Expansion Program

The first of the nation's all-purpose synthetic rubber plants to be reactivated under the government's expanded rubber program started production on October 12 at Port Neches, Texas, 20 days ahead of schedule.

The huge plant, designed with a production capacity of 60,000 long tons a year, has been modernized by engineers of United States Rubber Company so that it will produce more than 72,000 long tons a year when operating at peak load.

Aramco Names McDonald

J. H. McDonald, secretary and treasurer of Arabian American Oil Company,

The MONTH...

has been elected vice president and secretary of the company. He joined Aramco in 1945 after 21 years with Standard Oil Company of California.

Patents-Licensing Executive Joins Houdry Corporation

Houdry Process Corporation, Philadelphia, has appointed Roy C. Hackley, Jr., as vice president in charge of patents and licensing.

Hackley

Former special assistant to the Attorney General and chief of the Patent Section of the Department of Justice, Hackley had been in government service since 1943. He had previously been a captain attached to the office of the Army Judge Advocate General.

Hackley was awarded his J.D. by the Hastings College of the Law of the University of California, and practiced general law in California before he began to specialize in patent law.

Imperial President Predicts Record Refinery Expansion

Expansion to 100,000 barrels per day capacity by 1952 was predicted last month for Western Canadian refineries by G. L. Stewart, president of Imperial Oil Limited. He based his statement on the assumption that availability in the area of crude oil at an economic cost will be a stimulus to refinery construction.

There has previously been only about 30,000 barrels per day refining capacity in the entire northwest coastal area of Canada and the U. S., all dependent on California crude. The 260,000-barrel-per-day demand for oil products in the area has been met largely by California refining capacity.

A further incentive to refinery construction, Stewart believes, is the increased pipe line service available to manufacturers and producers in the prairie provinces. He pointed out that the Vancouver, British Columbia, area is now inaccessible because of high transportation costs, but that adequate pipe line facilities would make it a profitable market for oil products made in Western Canada.

Eastern Canadian refineries, which serve Quebec and Eastern Ontario, have 100,000 barrels a day capacity, and may also use prairie oil in the future. Ontario refiners may be required to make additions to their storage capacity to permit them to operate on Alberta crude during the winter months when Great Lakes navigation is closed.

Capacity of Kerr-McGee Wynnewood Plant Increased

Scheduled for December 1 completion, a $600,000 program of Kerr-McGee Oil Industries will increase the capacity of the Wynnewood, Okla., refinery from 6000 to 10,000 barrels.

Included in the program are remodel-

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ing conversion and additions to present fractionating towers, remodeling the light oils treating section, increasing steam power plant capacity, and installation of additional products cooling sections. Crude oil and products storage capacity is to be increased.

Also under construction is a 21-mile six-inch crude oil pipe line from Kermac's Butterfly station to the Tussy station, with pumping facilities. Present four-inch crude line from refinery to Tussy will be extended 27 miles to Sunray, Okla., and converted into a products line.

Oil, Chemical Firms Develop Catalytic Reforming Process

A new catalytic reforming process to increase the yield of higher quality gasoline which "could have a very important part to play in helping overcome the current benzol shortage" has been developed by The Atlantic Refining Company, in cooperation with Davison Chemical Corporation, manufacturer of the catalyst.

The new process and catalyst appear to have broad applications and to be a substantial improvement over other reforming processes, R. L. Hockley, vice president of Davison, said in a talk before the New York Society of Security Analysts.

Three Gulf Oil Scientists Are Promoted at Pittsburgh

Dr. Morris Muskat, formerly director of the Physics division, Gulf Research & Development Company, Pittsburgh, has been transferred to the general office of Gulf Oil Corporation's Production Department, where he will be technical assistant to K. C. Heald, vice president.

Dr. Muskat is succeeded as director of the Physics division by Dr. Frank Morgan, and Dr. Norman D. Coggeshall has been promoted to assistant director.

Dr. Muskat received his Ph.D. at California Institute of Technology in 1929 and joined Gulf's research organization that year. He was made director, Physics division, in 1936.

Esso Standard Advances Two as M. W. Boyer Resigns

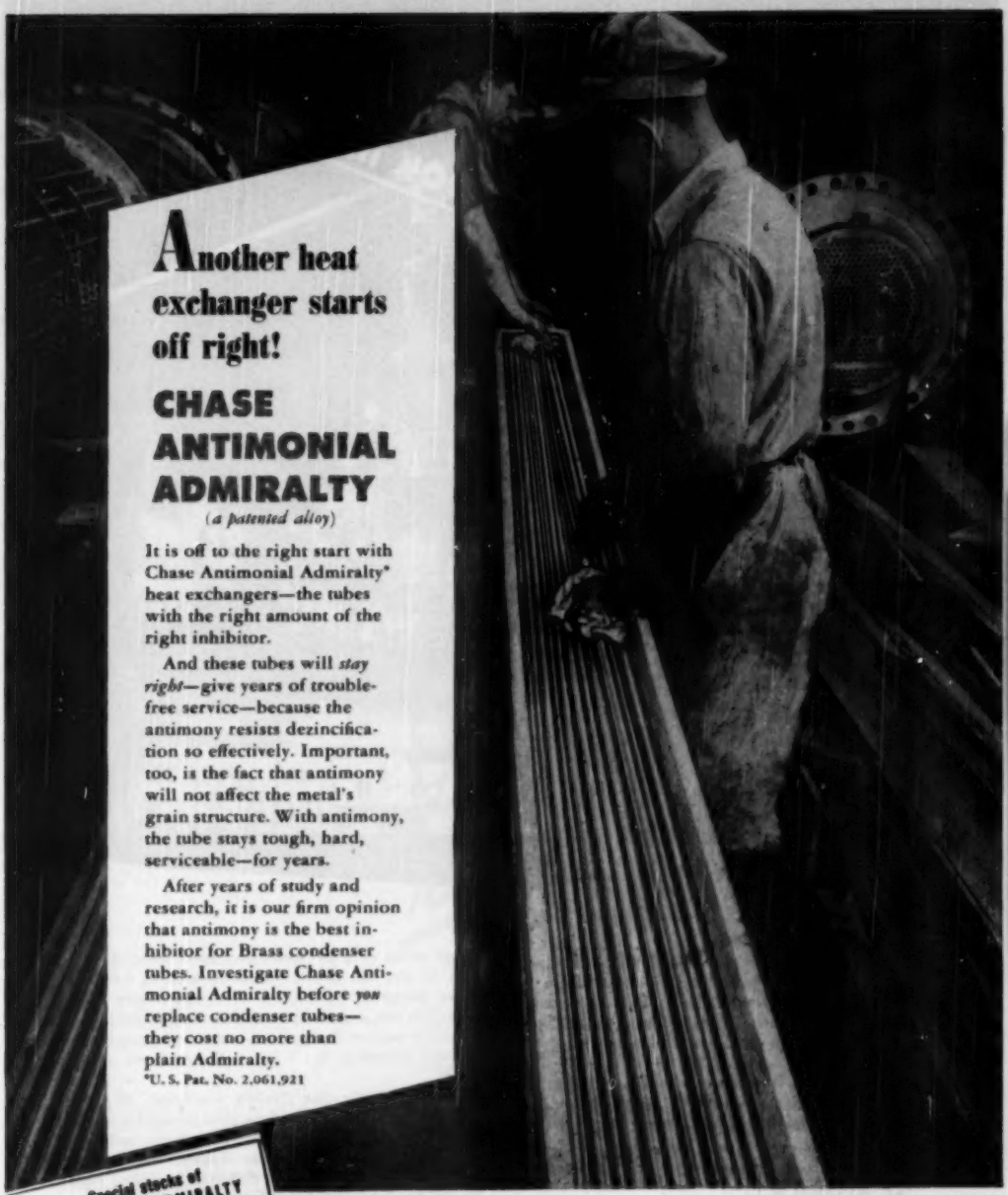
William Naden, Esso Standard Oil Company board member and general manager of manufacturing, has been elected a vice president of the company, and Herbert P. Schoeck, treasurer, has been named a director.

The promotions follow the resignation of Marion W. Boyer as vice president and director to become general manager of the Atomic Energy Commission.

South American Congress Will Meet in Montevideo

The first South American Oil Congress is being planned by the Instituto Sudamericano del Petroleo (ISAP), and will be held in Montevideo, Uruguay, March 12-16, 1951.

The Congress, expected to be the largest meeting of oil technicians, scientists and experts ever held in South America, will consider the best way to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increase crude production and improve manufacturing facilities. The meeting also has as its objective the investigation of possibilities of promoting the exchange of fuels between the South American countries and further the friendly intercourse and exchange of ideas between the men engaged in the oil industry.

President of the organizing committee is Carlos R. Vegh Garzon Eng., who is also president of the executive committee of ISAP.

J. E. Pew Warns Industry Of Government Controls

The oil industry seems to be a special target for heavy and outrageously unjust attacks intended to destroy public confidence in the industry, so that its operations can be brought under the strangling hands of government control and dictation.

This is the view of James E. Pew, Sun Oil Company, president of the Natural Gasoline Association of America, who made the opening address before an attendance of more than 350 at the Southern Regional Meeting of the NGAA and East Texas Natural Gasoline Men's Club in Tyler, Texas, October 27.

The anti-trust suits have as their purpose, he warned, the dismemberment of integrated oil companies, which, if successful, would destroy their efficiency to serve the public.

"Still fresh in our memories," he said, "is the bitter controversy over the Kerr Bill, the heated and totally irresponsible statements regarding the depletion allowance, and more recently, the attempt to subject crude oil prices to the terms of renegotiation legislation."

Pew declared that the rules that govern business competition, as set forth by our legislatures and courts, are no longer clear. As a result, business management, already burdened with the task of satisfying the interests of customers, employes, stockholders, and tax collectors, is today compelled to operate in a fog of legal threats and harassments. Anti-trust suits are given the widest possible publicity by government lawyers at the time they are filed, but the cases frequently are not brought to trial," he said, "declaring denials seldom catch up with the charges, a fact well known to those who make the charges.

"To stem the onslaught against industry, industrial leaders need the alert and enthusiastic assistance of everyone who gets income from the oil-business—all levels of management and supervision, all employes, all stockholders, all distributors and dealers, royalty holders, allied branches of the business, and its suppliers, too," Pew said. "Only an informed and enlightened public opinion can stop the attacks on our business and our livelihood. To keep the record straight we must speak at every opportunity, taking our case to the people and supplying them with the facts."

Technical discussions presented to the meeting included "Platforming—Its Potentialities and Limitations for the Natural Gasoline Industry" by W. F. Fulton, Warren Petroleum Corporation, Houston; "Practical Plant Lubrication" by Roy J. Chappell, Gulf Oil Corpora-

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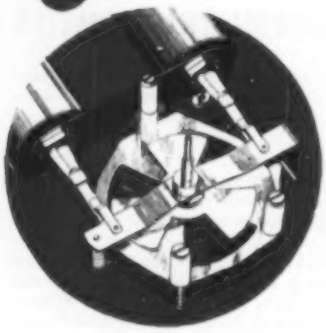

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tion; "Desulphurization" by Joe Parker, The Girdler Corporation, Tulsa, and "Practical Application of Seals and Packing" by C. E. Schmitz, Crane Packing Company, Chicago.

H. H. Beeson, Magnolia Petroleum Corporation, Dallas, and A. H. (Pete) Weil, United Gas Pipe Line Company, Shreveport, served as chairman of the two sessions. Major B. A. Hardey, independent producer, Shreveport, in an address told of the inroads of socialism and its effects on government and urged greater attention to government affairs by each citizen and active participation by voting in all elections.

L. S. Gregory, L. S. Gregory Company, Tulsa, presented "Practical Portable Plants" in which he described a portable plant of low installation and operating cost. Other papers were presented by M. R. Church, Shell Oil Company, Houston, "Waste Disposal at Gasoline Plants," and "The Use of LPG as Motor Fuel" by W. F. DeVoe, Phillips Petroleum Company, Bartlesville.

The "Cooling Tower," banquet and entertainment at the close of the meeting, was by courtesy of The Natural Gasoline Supply Men's Association.

Acting President Chosen By Republic Oil Refining

John M. Gardiner, vice president, has been made acting president of Republic Oil Refining Company until election of a president to fill the vacancy caused by the death on October 3, in Pittsburgh, of W. E. Huston.

Paul G. Benedum has been elected vice president of Plymouth Oil Company and Big Lake Oil Company as successor to Huston.

Republic's board chairman, O. D. Robinson, has been elected a director of Plymouth Oil Company.

Chemistry and Spectroscopy Conference Date Is Changed

The 1951 Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy will be held at the William Penn Hotel March 5-7, and not February 28-March 2 as previously announced.

The Conference is sponsored jointly by the Analytical Chemistry Group of the Pittsburgh Section of the American Chemical Society and the Spectroscopy Society of Pittsburgh.

Profits Provide Better Products, Wilson Declares

The wise use of profits enables today's oil industry to serve the expanding civilian and military demands, Dr. Robert E. Wilson, board chairman of Standard Oil Company (Ind.), stated at a rally sponsored by the OIIC of Metropolitan Detroit in cooperation with the Detroit Oil Men's Club.

Profits are fair in the oil industry and are lower than most people think, he declared. Surveys indicate that a 10 percent return on invested capital is considered to be a reasonable rate of profit, but there are few oil companies that make more than that on the average.

Using his own company as an example, Dr. Wilson pointed out that last year the customer's dollar returned Indiana Standard less than 8 cents. Stock-

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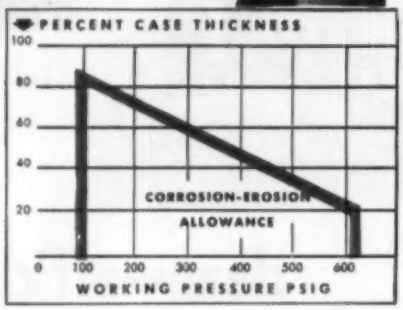

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holders received less than 3 cents, more than 60 percent of the profit being used for expansion to meet the growing demand for better products—"and we borrowed $50 million besides," he added.

Apparent profits are further diminished, he asserted, when it is remembered that much of the crude being produced today is from reserves discovered in the days of lower costs, 8, 10 or 12 years ago.

"We are wearing out equipment that we bought years ago at lower prices. Our depletion and depreciation charges are inadequate to cover present replacement costs," Dr. Wilson said.

Process Control Instrument Orders Over Wartime Peaks

Industrial process control instrument makers who now face the possibility of an all-time production record are ready to repeat or better the emergency production peaks they made during World War II, it was revealed at the mid-year meeting of the Recorder-Controller section of the Scientific Apparatus Makers Association.

"Process control instruments orders for the first eight months of 1950 climbed from a post-war low in 1949 to a steadily increasing production which, in the third quarter, reached a new peak," the SAMA executive committee reported. "During the past three months incoming orders exceeded by about 5 percent the highest comparable period during the peak war years, in 1942."

Mathieson Names Wojcik to Petro-Chemical Research

Dr. B. H. Wojcik has been appointed associate director of petrochemical research at Mathieson Chemical Corporation, Baltimore. A specialist in the field of organic chemistry, Dr. Wojcik was with Hooker Electrochemical Company prior to his Mathieson appointment.

While working toward his Ph.D. in chemistry at the University of Wisconsin, Dr. Wojcik was a graduate teaching assistant. He joined Hooker in 1934 as a research chemist, and was in charge of the Manhattan Project work done by that company during the war.

U. S. Refinery Advantage Called Deterrent to Russia

U. S. refining superiority is one of the major reasons that Russia hesitates to launch an all-out war against this country, in the opinion of Walter S. Hallanan, NPC chairman.

While the advantage in reserves is important, Hallanan pointed out, "In the event of war, it would not be the hypothetical Russian reserves that would count. It would be the refineries, and so far as known to experienced oil men, practically none of them would be out of reach of American and Allied bombing." Stalin is equally as weak in refining capacity as in reserves, he said.

In summarizing Russia's known oil facilities, Hallanan stated that the Soviet Union has found only small amounts of new oil, and these are scarcely developed.

"It must still depend heavily on Baku, Rumania and a limited amount of Eastern Siberia. The oil reserves of the U. S.

The MONTH...

are six times greater than those of Russia and its satellites. Our production is seven times greater, and in refining capacity, which is the big military factor, the U. S. has a 7 to 1 advantage," he said.

Stone&Webster Engineering Names Southwest Manager

Stone & Webster Engineering Corporation has appointed Robert Jefferson Carter as Southwestern district manager for the corporation with offices in the Esperson Building, Houston. Carter succeeds A. T. Krook who was elected president of Stone & Webster Canada Limited after nine years as manager of the Houston office.

Carter

A graduate of Washington University of St. Louis, Carter received his engineering degree in the class of 1924. After 15 years of engineering experience in the petroleum industry, he joined the Stone & Webster organization late in 1939.

NGAA Regional Meeting To Amarillo In December

The Panhandle-Plains regional meeting of the National Gasoline Association of America will be held in the Herring Hotel, Amarillo, Friday, December 8. I. Earl Nutter, general superintendent of the Panoma Corporation, Amarillo, is chairman of the program committee.

L. L. Dresser, Dresser Engineering Co., Tulsa, President of the Natural Gasoline Supply Men's Association has appointed a committee to handle the NGSMA sponsored social hour at the Amarillo meeting of which T. R. Cross, Paramount Supply Company, is chairman.

Koppers Selects Thiessen To Head Laboratory Section

Dr. Gilbert Thiessen, former technical advisor for the Chemical division of Koppers Company, Inc., has been named manager of the laboratory section of the company's Central Research department. He will supervise and direct all Koppers laboratory research performed in company-owned laboratories or plants and by contract in academic and commercial laboratories.

Vice President Is Named

Jay E. Crane has been elected vice president of Standard Oil Company (New Jersey) to succeed Robert T. Haslam, who has retired as vice president and director of the company. Crane has been a member of the company's board of directors since 1944.

1951 Instrument Meet Set

The Sixth National Instrument Conference and Exhibit, sponsored by the Instrument Society of America, will take place in the Sam Houston Coliseum, Houston, September 10-14, 1951.

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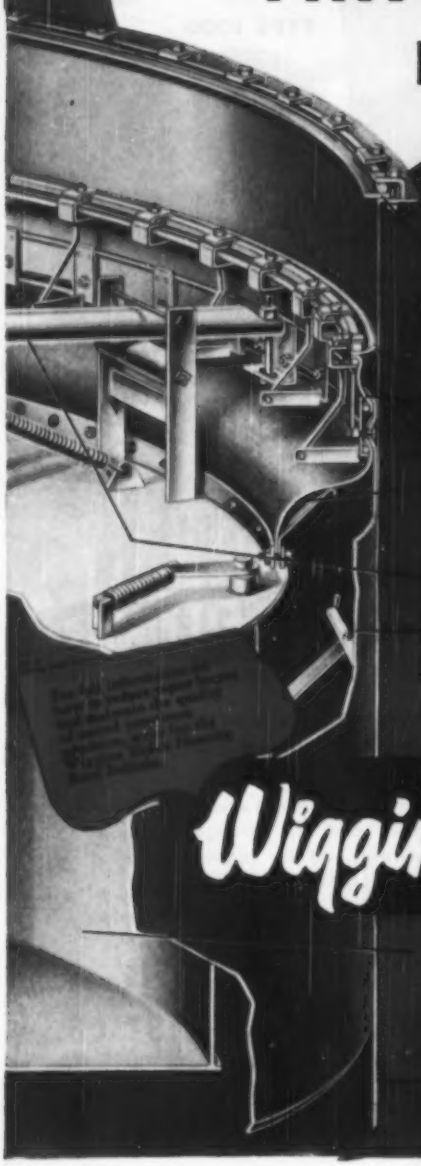

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GENERAL AMERICAN

SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Products: Properties, Utilization and Analysis

Cold Starting Performance of High Speed Diesel Engines and Their Fuels. L. D. DERRY and E. B. EVANS. *Jour. Inst. of Petroleum*, **36** (1950) pp. 389-421.

The objective of the investigation reported was to determine the effect on cold starting of fuel properties such as ignition quality, volatility, viscosity, and cloud point under different atmospheric conditions. Studies were made in a single-cylinder direct-injection engine and in six standard multi-cylinder automotive-type engines that represented a variety of types of combustion systems. It was found that cetane number is the most important single fuel property affecting starting performance, and that volatility is second in importance. In general, engine performance becomes better as these properties improve, but with some engines design may be such that fuel characteristics generally have little effect. This is the case when compression temperatures are high because of high compression ratios, high motoring speeds, or the addition of heat by auxiliary starting devices such as heater plugs. When volatility is important, diesel index may give an excellent indication of the relative starting properties of fuels. Some engines were found to be relatively short of excess fuel for starting. This condition may be aggravated by a governor design that cuts off excess fuel at idling speed, thus causing the engine to stall. In such cases higher fuel viscosity may be beneficial, and may be more important than volatility. The effect comes about because of the increased volumetric efficiency of the fuel pump with increased viscosity; the more worn the pump the more marked is the effect. Below the cloud point of the fuel, starting performance is poorer, due to partial blocking of the filter by wax crystals. This effect is most noticeable in cases where there is already a deficiency of excess fuel for starting.

Boundary Lubrication of Steel. Blends of Acids, Esters, and Soaps in Mineral Oil. WILLIAM DAVEY. *Ind. Eng. Chem.*, **42** (1950) pp. 1837-41.

In lubrication of metal surfaces, even with the best lubricants, extensive damage to the surfaces occurs. A major component in the friction is caused by the making and breaking of numerous contacts between the moving surfaces with frequent welding of one to the other. Two types of surface film are involved in boundary lubrication, those formed by adsorption of polar compounds at the surface and those produced by chemical reaction of the lubricants at the surface. The studies were made by means of the four-ball machine. Acid blends reduce friction by physical adsorption of the acid and reduce wear by formation of soap films of low shear strength. Esters were found to be less effective in wear reduction since soap formation can occur only under extreme conditions. Metal soap blends are most effective in boundary lubrication if metal interchange between the soap and iron can occur. The addition of sulfur greatly improves the lubricating properties of acid, ester, and soap blends. Sulfide films, that facilitate absorption of polar compounds at the surface, are formed and give enhanced antiseizure properties. A bibliography of 20 references is included.

Extreme Pressure Lubricants. Phosphorus Compounds as Additives. WILLIAM DAVEY. *Ind. Eng. Chem.*, **42** (1950) pp. 1841-7.

The extreme pressure properties of several phosphorus compounds, blended in mineral oil, alone, and in the presence of fatty acids, or esters, or sulfur, were studied by means of the four-ball machine. Phosphites were found superior to phosphates as extreme pressure additives and alkyl esters were found superior to aryl esters. The addition of fatty acids, esters, or sulfur improves the extreme pressure properties of blends of phosphites and phosphates. Some thiophosphites and thiophosphates were found to possess good extreme pressure properties. Properties of some chlorinated phosphites and phosphates were studied, and compounds containing a $-CCl_3$-group were found to be possessed of excellent lubricating properties and to be active at low concentrations. The mechanism by which phosphorus compounds reduce friction and wear was studied. Phosphorus esters effect lubrication of steel by reacting chemically to form phosphide films that are smoothly worn away. In general the extreme pressure activity shown by phosphites and phosphates is of a lower order than that shown by halogen-sulfur additives, but is of the same order as that shown by lead soap-sulfur additives.

These abstracts from the current literature of science and technology (not including trade journals easily available) were prepared by Drs. Leslie and Coats of The Leslie Laboratories, Traver Road, Ann Arbor, Mich., which will supply, at cost, photostatic copies of original articles. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also may be had by arrangement with the laboratories.

The Nature and Scope of Temporary Corrosion Preventives. D. CLAYTON and M. C. THOMPSON. *Jour. Inst. of Petroleum*, **36** (1950) pp. 423-8.

The broad purpose of temporary corrosion preventives is to protect metal surfaces against corrosion during transport and storage, and in such manner that articles can be restored to their original state by easy removal of the protective film, mainly through the use of common petroleum solvents. Most such preventives function by providing a water-resistant barrier and by forming an adsorbed layer on the metal. The usual types of temporary corrosion preventives are given, together with some of the newer developments. The field of use is defined, and the principal causes of failure reviewed. Finally, some of the questions arising in accelerated testing are raised.

Assessment of the Protective Value of Temporary Corrosion Preventives (with Particular Reference to Humidity Cabinet Tests). T. G. CLINTON. *Jour. Inst. of Petroleum*, **36** (1950) pp. 428-35.

Factors that are likely to produce breakdown of temporary corrosion preventives under conditions of service are discussed, and certain performance tests applicable to the evaluation of the protective qualities of these coatings are considered. The use of a humidity cabinet and an intermittent salt-spray test are described in detail. Accelerated weathering, continuous salt-spray, and natural weathering tests are described. There is at present no single performance test that is likely to forecast the behaviour of protectives under all conditions of service.

A Method for the Evaluation of Soft-Film Temporary Corrosion Preventives for Ferrous Articles. T. P. HOAR and G. C. SMITH. *Jour. Inst. of Petroleum*, **36** (1950) pp. 448-57.

The authors believe that the most rational evaluation of soft-film temporary corrosion preventives should be a test of a mechanically poor coating under relatively moderate conditions. A very thin but reproducible film is deposited from a volatile solvent on a clean steel surface, and the incidence of corrosion caused by small drops of distilled water

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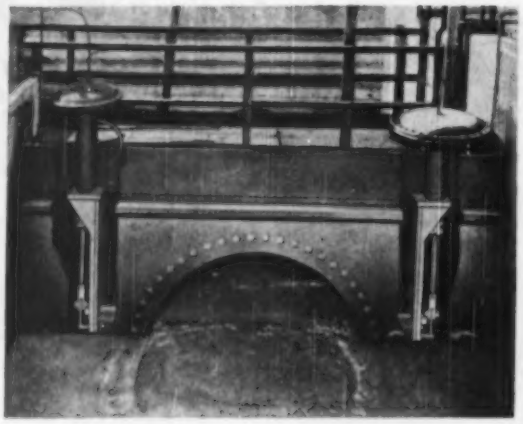

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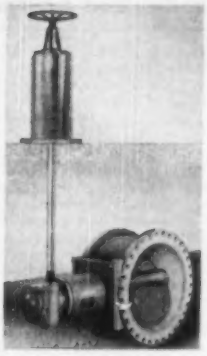

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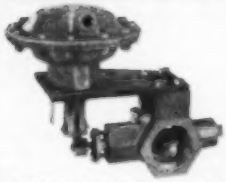

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is determined after 24 hours. The composition of three parts mineral jelly with one of lanolin is shown to be considerably better than plain jelly. It is further improved by the substitution of woolgrease for lanolin. The addition of 2% of sodium petroleum sulphonate to mineral jelly greatly improves its protective value.

Application of an Accelerated Atmospheric Corrosion Test to the Assessment of Temporary Corrosion Preventives. R. St. J. Preston and E. G. Stroud. *Jour. Inst. of Petroleum*, **36** (1950) pp. 457-63.

An accelerated atmospheric corrosion test, in which the specimens are exposed at constant temperature to an atmosphere of controlled humidity and containing sulphur dioxide, has been applied in valuing temporary corrosion preventives, including products from lubricating oil, through petroleum jelly, to bitumen. A plain humid atmosphere was not aggressive enough to break down most of the samples, in spite of a prolonged period of test.

Tests of the Protective Value of Temporary Corrosion Preventives on Steel. S. G. Clarke and E. E. Longhurst. *Jour. Inst. of Petroleum*, **36** (1950) pp. 463-73.

The authors present results of corrosion tests made by relatively simple methods. Free exposure to the outdoor atmosphere, the ARE salt-spray test and a non-streaming humidity test were found to give comparable orders of merit for several protective coatings on steel. Outdoor exposure is in general too severe and too variable for testing oil films. A sprayed-on water-droplet test discriminated between oil films. Increasing the film weight of lanolin gave increasing protection in an outdoor test. A marked reduction in the weight of steel oxidized in the ARE salt-spray test was found when extremely thin oil films were used.

Infrared Analysis of Certain C_1-C_4 Hydrocarbon Mixtures. James D. Stroupe. Rohn & Haas Company, Philadelphia, Pa.

Infrared analytical methods were developed for the direct determination of small amounts of ethane, propane, n-butane, and isobutane in natural gas and purified methane streams. Accuracies of ±0.1 percent were obtained with the permanent gas absorption cell of the Beckman IR-2 spectrophotometer. An additional comparison cell set permits the direct determination of methane to within ±0.5 percent. The methods used have been satisfactory in routine analysis for the past two years.

Determination of Oil in Paraffin Waxes. C. W. Layton. *Analytical Chem.*, **22** (1950) pp. 1168-9.

The method described in the article was developed for testing deoiled wax in conjunction with plant operation where test results were needed as quickly as possible in the interest of plant efficiency. It was also desired to have a method that required no elaborate or delicate equipment, and which was as simple as possible, so that plant operators could obtain reliable results. A rapid method developed in which the sample is chilled with dyed methyl ethyl ketone to —25° F., a portion of the solvent-oil mixture filtered off, and an

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aliquot of the filtrate reacting with a sodium bisulfite solution in a skim milk test bottle. The oil is separated from the mixture by centrifuging, and the volume read. Results of this method check closely with ASTM method D 721-47. The method is particularly suitable for samples of low oil content, that is under 5 percent oil, but with modifications has been used for oil up to 75 percent.

Chemical Composition and Reactions

The Reaction of Cyclopentane with Mercury 6($^3P_1$) Atoms. By G. A. Allen, D. L. Kantro and H. E. Gunning. *Jour. Am. Chem. Soc.*, **72** (1950) pp. 3588-93.

The reaction of cyclopentane with mercury atoms in a static system at 30° C., over the pressure range from 5 to 200 mm. was studied. The products of the reaction are hydrogen, cyclopentene and cyclopentylcyclopentane. The pressure decrease observed was attributed to the condensation of cyclopentylcyclopentane. The nature of the products formed as well as the yield suggest that the mercury photosensitized decomposition of cyclopentane strongly resembles those of the lower paraffins. A reaction mechanism is proposed, which involves the formation of cyclopentyl radicals. It is believed that this is consistent with the data observed.

The Kinetics of the Thermal Decomposition of Normal Paraffin Hydrocarbons. I. The Inhibition of Chains and the Nature of the Residual Reaction. F. J. Stubbs and Cyril N. Hinshelwood. *Proc. Roy. Soc.* (London), **A200,** 458-73 (1950). **II. Comparative Measurements on the Series from Propane to Decane.** *Ibid.*, **A201** (1950) pp. 18-26.

Additions of NO or propylene lower the decomposition of paraffin hydrocarbons to a limiting value. An extra large quantity of NO has no further effect, thus indicating that the residual rate corresponds to a molecular reaction. Curves are given for the decomposition at 530° C. of paraffins from propane to decane. Inhibition of the decomposition of pentane by propylene was studied. NO is about 12 times as effective as propylene. The rate of decomposition of olefins increases rapidly with the number of carbon atoms; propane decomposes more rapidly than propylene; butane and 1-butene, at the same rate; and 1-hexene decomposes faster than hexane. In the second series of studies the rates of the NO-inhibited decompositions of these hydrocarbons were measured over a range of pressures. The molecular rearrangement process increases in proportion relative to the chain reaction with ascent of the series, and for any given hydrocarbon with increasing pressure. For each hydrocarbon, the order of reaction varies between the first and the second. Decomposition rate for a given hydrocarbon pressure tends to a limit as the series is ascended.

The Low-Temperature Polymerization of Isobutene, II. P. H. Plesch. *J. Chem. Soc.* (1950) pp. 543-56.

The polymerization of isobutene in hexane solutions by $TiCl_4$ with water and trichloracetic acid as co-catalyst was

studied in the temperature range from —90 to 0° C., using an adiabatic technique. The data indicates that the reaction is first order with respect to the co-catalyst. The activation energy for chain initiation is probably less than 4 kcal. per mol., but that for chain termination may be as high as 10 kcal. per mol. The high energy of chain termination is probably due to the rearrangement of the ion pair at the growing end of the polymer where termination takes place. The analytical data indicate that the co-catalyst may be attached to the end of the polymer chain at termination. The carbonium-ion theory is believed to be the best explanation of the phenomenon.

Polymerization. XII. The Metalation of Olefins and Dienes and their Use in Alfin Polymerization of Butadiene. AVERY A. MORTON, DRANK D. MARSH, ROBERT D. COOMBS, ANNE L. LYONS, SIEGFRIED E. PENNER, HUGH E. RAMSDEN, VERNON B. BAKER, ERNEST L. LITTLE and ROBERT L. LETSINGER. *Jour. Am. Chem. Soc.*, **72** (1950) pp. 3785-92.

The authors describe the metalation of ethylene, several straight chain and branched olefine, diallyl and some conjugated dienes. These compounds are metalated on the methylene or methyl group next to a double bond, if present, otherwise on a vinyl carbon. If only one hydrogen is on the adjacent carbon, rearrangement or other changes occur. The metalated olefins piperylene make poor Alfin catalysts, but metalated diallyl is a fair catalyst. Olefins do not affect a good Alfin catalyst but dienes may possibly do so by reacting with the catalyst.

Alkylation. R. NORRIS SHREVE. *Ind. Eng. Chem.*, **42** (1950) pp. 1650-60.

The article is one of several included in a review of chemical engineering unit processes. Oxygen and nitrogen alkylation are first considered, carbon-carbon petroleum alkylations, carbon-carbon aromatic alkylations, miscellaneous carbon-carbon alkylations, sulfur alkylation, silicon alkylation, metal alkylation, and equipment used in alkylation processes. A bibliography of 290 references is included.

Pyrolytic and Catalytic Decomposition of Hydrocarbons. VLADIMIR HAENSEL and MELVIN J. STERBA. *Ind. Eng. Chem.*, **42** (1950) pp. 1739-46.

The article is one of several in a review of chemical engineering unit processes. Thermal cracking is first considered, along with some articles on continuous coking. Catalytic cracking is then considered, including the mechanism of the reactions and functioning of the catalyst. Industrial applications of catalytic cracking are next reviewed, followed by reforming and dehydrogenation. A bibliography of 85 references is included.

Fundamental Physical and Chemical Data

Physical Chemistry of Hydrocarbons, I. Edited by A. FARKAS. 453 pp. (1950). Pub. by Academic Press, Inc., 125 E. 23rd St., New York.

The book is the first of two volumes dealing with the physical chemistry of

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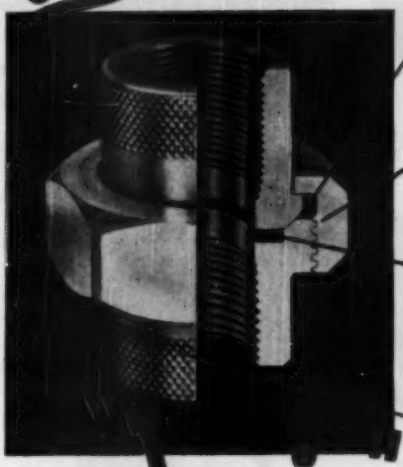


BALL AND CONE SEAT
This is the same leak-proof sealing arrangement that has made WECO UNIONS leaders in the Oil Industry for 15 years

ACME THREADS . . . FASTER MAKE-UP
Fewer turns are required for seating contact of subs which draw up tighter with less pull on the wrench

RESILIENT, REPLACEABLE GASKET
Acting as supplementary seal, it protects metal-to-metal seat against abrasion and corrosion from line fluids and gases

KNURLED SUB ENDS
An exclusive feature minimizes wrench slippage, means easier, faster starting on pipe ends

WECO Junior
Fig. 342

EVEN after repeated make-up and break-out, WECO "Junior" all steel unions continue to give perfect service. The metal-to-metal ball and cone seat, meeting in a concentric circle is self-aligning and perfect seating for a leak-proof seal. The heavier wall construction of sub ends . . . the rugged nut with heavy acme threads gives them greater strength and longer life.

These 3000 lb. non-shock C.W.P. Unions are available ⅛" through 2"; machine finish or Wecalyte cadmium plated.

Other platings on request.

ASK FOR WECO "JUNIOR" UNIONS AT YOUR INDUSTRIAL, MILL SUPPLY, OR OIL FIELD SUPPLY STORE.

Sizes ⅛ through 1" packed 24 to the carton; larger than 1" packed 12 to the carton. For adequate stocks of all sizes . . . for easier storing on warehouse and stock room shelves, order WECO "JUNIOR" UNIONS by the carton.

WECO

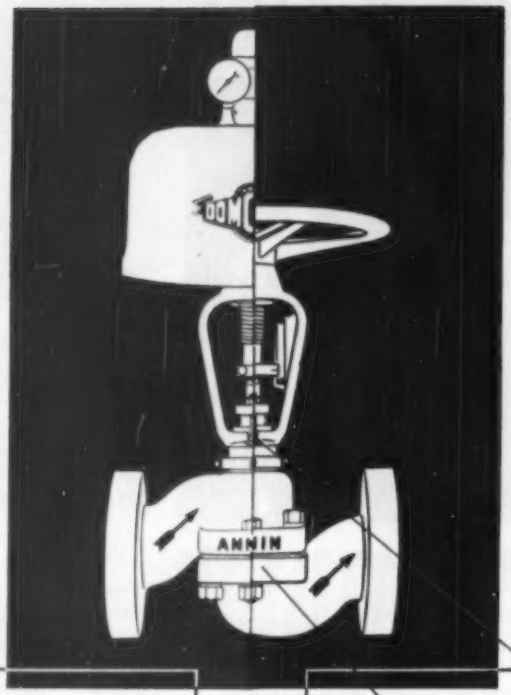
WELL EQUIPMENT MFG. CORP.

HOUSTON 1, TEXAS

CHIKSAN COMPANY

Export Sales: CHIKSAN EXPORT COMPANY

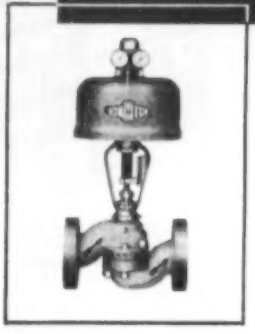
NOW YOU CAN HAVE
Valve Flexibility
IN REFINERY SERVICE



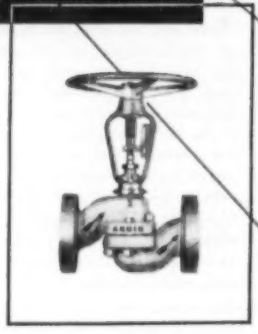
Single-seated for precise automatic or manual control of hard-to-handle fluids. Completely interchangeable. Low maintenance cost.

Annin Domotor and Handwheel Valves are companion valves that permit great flexibility in operation. One may be converted into the other in a matter of minutes. This together with the various characterized valve trims offered, not only permits flexibility in application but reduces your inventory of valves and parts. Maintenance costs are also reduced since almost all servicing can be done without removing the valve from the line.

- PRESSURES TO 3000 PSI
- TEMPERATURES TO 1000°F
- SIZES ¾" TO 4"
- AVAILABLE IN WIDE RANGE OF ALLOYS
- QUICK CHANGE VALVE SEAT
- 50% WEIGHT REDUCTION

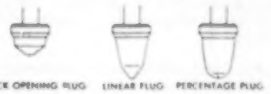


DOMOTOR—*For Automatic Control*
Sealed piston in dome actuated by internally controlled differential pressures insures powerful stable valve action. Built-in null type positioner unit. Supply and instrument pressure gages. Light weight—Economical.



HANDWHEEL—*For Manual Control*
Valuable companion valve to Domotor. Ideal for batch and non-continuous fluid processing control. Operates over same range as Domotor. Valve trims interchangeable.

CHOICE OF CHARACTERIZED FLOW



It's a quick and simple matter to change the flow characteristics in Annin Domotor and Hand Operated Valves. Body separates at seat for on-the-job replacement.

CHOICE OF SEATS

Increased flexibility is yours since you can have a composition or metal seal to meet any fluid condition. Easy to replace. No grinding-in operations necessary.

It will pay you to investigate Annin Valves.

THE ANNIN COMPANY
3500 Union Pacific Avenue, Los Angeles 23, California

hydrocarbons. It deals with such subjects as chemical bond in hydrocarbon molecules, the molecular structure of hydrocarbons, mass spectroscopy in hydrocarbon analysis, optical properties of hydrocarbons, optical methods of hydrocarbon analysis, electrical properties of hydrocarbons, solvent extraction of hydrocarbons, solid-liquid equilibria of hydrocarbons, and chemical thermodynamic equilibria among hydrocarbons.

Raman Spectra. Hydrocarbons and Oxygenated Compounds. W. G. BRAUN, D. F. SPOONER, and M. R. FENSKE. *Analytical Chem.*, **22** (1950) pp. 1074-1114.

The authors present the Raman spectra of 119 compounds in the form of graphs and tables. These data supplement the spectra of 172 compounds previously reported. The indexes of the spectra of the hydrocarbons are given in five tables which tables, in addition to the name and spectrum number, give the physical properties of the compounds examined, the best literature data on the properties, and, when known, the purities of the materials.

The Direct Determination of the Critical Temperature and Critical Pressure of Normal Hydrogen. DAVID WHITE, ABRAHAM SOLOMON FRIEDMAN *and* HERRICK L. JOHNSTON. *Jour. Am. Chem. Soc.*, **72** (1950) pp. 3565-8.

The authors review the work that has been done in determining the critical temperature and pressure of hydrogen. An apparatus for the direct measurement of critical temperature and pressure is described. Critical constants of normal hydrogen were found to be 33.24° K. for the critical temperature and 12.797 atmospheres for the critical pressure. The vapor pressure of normal hydrogen in the immediate vicinity of the critical temperature was also measured. Results of the work agree very closely with those of the generally accepted values determined by Onnes at Leiden.

Manufacture: Processes and Plant

Holdup in Batch Distillation. Critical Reflux Ratio. ARTHUR ROSE, T. J. WILLIAMS, and CHARLES PREVOST. *Ind. Eng. Chem.*, **42** (1950) pp. 1876-9.

In spite of considerable work on the subject, no practical proved means of predicting the effect of holdup and charge size in batch distillation is available at the present time. In the experiment reported the effect of holdup-to-charge ratio on sharpness of separation of binary mixtures was studied by making nine series of runs in two laboratory columns. Increasing the ratio of holdup to charge gave a sharper separation, a less sharp separation, or made no difference in the sharpness of separation, depending on the reflux ratio. A critical reflux ratio was noted at which holdup had no effect on the sharpness of separation. As the reflux ratio was increased above this critical value the effect of increased holdup was detrimental to sharpness of separation. At reflux ratios below the critical value the effect of increased holdup was beneficial to the separation. The critical reflux ratio was different for columns with different numbers of theoretical plates. For a 20-plate column the critical ratio was 9:1, whereas under the same conditions the critical ratio for a 40-plate column was 24:1. A bibliography of 14 references is included.

Hydrodesulfurization of Heavy Petroleum Oils. E. C. HUGHES, H. M. STINE and R. B. FARIS. *Ind. Eng. Chem.*, **42** (1950) pp. 1879-82.

Sulfur contents of several high-sulfur gas oils and of high-sulfur reduced crudes were reduced to those of corresponding fractions from low-sulfur Illinois crude by applying hydrodesulfurization in a mild manner. The cobalt oxide-molybdenum oxide-aluminum oxide catalyst was used at 750° F. 1000 cubic feet of hydrogen per barrel of hydrocarbon was applied, and the operation was conducted under 300 psi. In some instances part of the charge was in the liquid phase. The distribution of sulfur compounds between the paraffinic-naphthenic fraction and the aromatic fractions before and after desulfurization of the gas oil was determined by silica gel fractionation and by sulfur analyses. Reduced crude was distilled and asphalts were prepared from the bottoms. In desulfurizing the West Texas reduced crude, conditions used were 750 F., 400 psi., and 2000 cubic feet per barrel of charge.

Studies of the Fischer-Tropsch Synthesis. VII. Nitrides of Iron as Catalysts. ROBERT B. ANDERSON, J. F. SHULTZ, BERNARD SELIGMAN, W. KEITH HALL and H. H. STORCH. *Jour. Am. Chem. Soc.*, **72** (1950) pp. 3502-8.

It was found that the conversion of iron in reduced synthetic-ammonia-type catalysts to nitrides by ammonia treatment greatly increased their activity in the Fischer-Tropsch synthesis. Catalysts reduced to e-phase nitrides yielded a product of lower average molecular weight containing more gaseous hydrocarbons and oxygenated molecules than products obtained from corresponding reduced catalysts. Nitrided iron catalysts appear to resist oxidation and deposition of free carbon, and have great stability and long life. It is believed possible that the arrangement of spacing of iron atoms in the hexagonal carbide and e-phase nitrides cause the high activity of these catalysts. The way that interstitial compounds or carbon and nitrogen act as substrates for catalysts of high activity is not understood, but it may possibly be related to differences in the geometry of the resulting catalytic surfaces.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

Tetracosane
alpha-Bromoisocaproyl bromide
Hemimellitic anhydride
Vinyl fluoride
2,3-Dichlorodiphenylamine
2-Methyl-5-n-butylpyridine
4-Chloro-1,2-dimercaptobenzene
Chloropentafluoroethane
Methylene fluoride
p',p''-Dicyanoterphenyl
1,4-Dimethylimidazole
N-Methyl thiopropionamide
1-Cyanobutene-2
Di-(2-hydroxy-5-chlorocyclohexyl)methane
Heptanetriol-2,4,6
4-Methylhexanol-1
2-Iodo-3-methylbutane
Cyclobutane
Durenol
Pentamethylphenol
1,1,1-Tribromoethane

Science and Technology

Power Characteristics of Mixing Impellers—Part II. J. H. RUSHTON, E. W. COSTICH, and H. J. EVERETT. *Chem. Eng. Progress*, **46** (1950) pp. 467-76.

Data are given on flat-blade turbines, turbines without baffles, turbines with baffles, and other types of impellers. The effect of liquid viscosity and liquid density is shown. Speed-power relations are given. The effect of physical dimensions of the impellers and of the tanks are discussed. Data are presented in detail in tabular form and are also interpreted in graphical form.

Japanese Refining Industry Nears Demand Requirement

Output from nine rebuilt refineries on Japan's east or Pacific Coast, together with that of "indigenous" refineries, can meet the minimum requirements of the Japanese economy, except for gas-oil and lubricating oil, a U. S. observer stated.

Rehabilitation of the coast refineries is virtually complete, reported J. K. Kelsey of Standard-Vacuum Oil Company, New York, who served from February to August this year as refining consultant with the Supreme Command of the Allied Powers.

Gas-oil requirements can be covered, Kelsey believes, if refineries are revised to correct the discrepancy between gas-oil and diesel oil. The country's lube oil shortage might be relieved if one or more of the nine refineries would substitute contact filtration for contact re-run plants.

Illustrating the advanced thruput accomplished during the past year, Kelsey reported that from February to July, 1950, the stepup (in barrels per day) for gasoline was 1870 to 5960; kerosine, 177 to 740; gas-oil, 277 to 665; fuel oil, 3520 to 12,770; lubricating oil, 183 to 2030; and asphalt, 815 to 1560.

LPGA Names Secretary For New Mountain District

J. C. Crawford of Denver has been appointed district secretary of the newly organized mountain states district of the Liquefied Petroleum Gas Association. This is the third district headquarters to be established by LPGA. Others are located in San Francisco and Wichita, Kan.

Crawford has been associated for the past several years with both the Colorado Petroleum Marketers Association and Colorado Liquefied Petroleum Gas Association. He was executive vice president of the latter organization.

INCREASE
VAPOR PRESSURE
IN YOUR
MOTOR FUEL

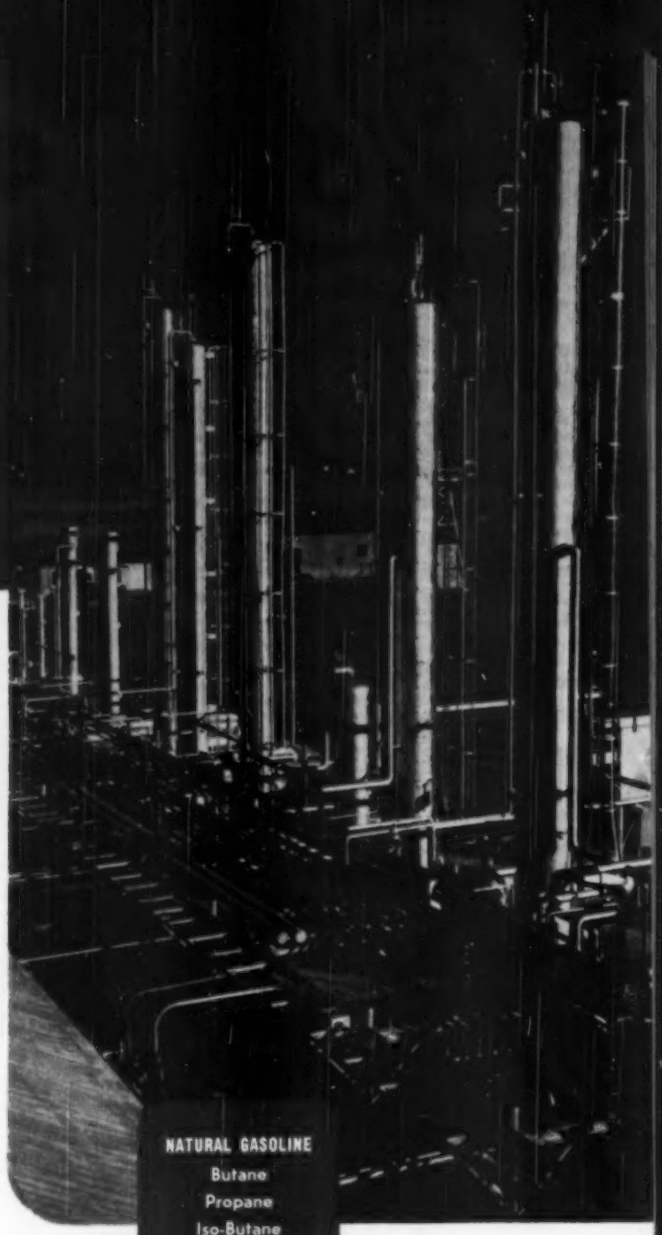
with

WARREN'S

Stabilized

NATURAL GASOLINE OR STA-VOL-ENE

The recent action of the A.S.T.M. Committee D-2 (Petroleum Products) provides for an increase from 13.5 to 15 lbs. R.V.P. maximum vapor pressure for refineries marketing gasoline in the northern states. WARREN'S Natural Gasoline and Butane give greater volatility and higher octane rating; provide the necessary instant starting anti-knock, carbon-free elements which assure a balanced motor fuel.



NATURAL GASOLINE
Butane
Propane
Iso-Butane
Iso-Pentane
Hexane
Heptane
STA-VOL-ENE

WARREN'S MADDEN, TEXAS PLANT

For Better Blending

and KNOCKLESS, QUICK-STARTING, CARBON-FREE MOTOR FUEL

WARREN PETROLEUM CORPORATION

Producers, Manufacturers, Exporters and Marketers

Export Terminals: Corpus Christi, Port Arthur, Baytown, Texas City, and Norsworthy, Houston, Texas.

TULSA 2, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren

Crude Oil, Natural Gasoline and Liquefied Petroleum Products

Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, August 15, 22, 29 and September 5 and 12, 1950)

REFINING

U.S.P. 2,518,577. Stabilization of Organic Compounds. R. B. Thompson and J. A. Chenicek to Universal Oil Products Company.

Cracked gasoline contains 0.0001-0.01 percent by weight of an inhibitor with the formula $HOC_6H_4\text{-}NR\text{-}CH_2\text{-}C_6H_3(R^1)OH$ where R is hydrogen or a hydrocarbon radical and R^1 is hydrogen, a hydrocarbon, or an alkoxy radical. N-(hydroxy benzyl)-p-aminophenol is an example of the inhibitor. Oxidative deterioration of the gasoline is inhibited by the additive.

U.S.P. 2,518,668. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are broken by treatment with surface-active oxyalkylated derivatives of diphenylolmethanes of special constitution.

U.S.P. 2,518,677. Separation of Hydrocarbons Using Urea Complexes. P. J. Garner, L. N. Goldsbrough and T. B. Buyers to Shell Development Company.

Straight chain hydrocarbons are separated from their mixture with non-straight chain hydrocarbons by contacting the mixture with an aqueous urea solution to selectively form crystalline molecular complexes of urea with the straight chain hydrocarbons. A certain small amount of an alkali metal alkyl sulfate, such as sodium decyl-2-sulfate, and a neutral water-soluble electrolyte, e.g., ammonium sulfate, are added to the reaction mixture for promoting association of the complex crystals with the aqueous solution and aiding in depressing emulsification.

U.S.P. 2,519,150. Method and Apparatus for Stripping Fluidized Solids. P. Ostergaard to Gulf Oil Corporation.

Details are claimed of a process and apparatus for stripping entrained vapors from finely divided fluidized solids.

U.S.P. Re. 23,262. Azeotropic Distillation of Toluene. H. C. Reed and B. M. Holt to Union Oil Company of California.

Details are claimed of a continuous process for the separation of aromatic from non-aromatic hydrocarbons of similar volatility by azeotropic distillation in the presence of an azeotrope former, such as methyl ethyl ketone, and a solvent of lesser volatility, such as water.

U.S.P. 2,519,336. Separation of Dialkyl Benzenes. L. K. Beach and C. E. Morrell to Standard Oil Development Company.

In a mixture of p- and m-xylene, the m-xylene is sulfonated until at least ¼ of the xylenes remain unreacted. A raffinate fraction of the unreacted xylenes is separated from an acidic extract of the sulfonates. This extract is steam distilled to obtain an m-xylene rich cut and a higher boiling p-xylene rich cut. The raffinate and the p-xylene rich cut are cooled to freeze out p-xylene crystals. The remaining mother liquors are recycled to the sulfonating step.

U.S.P. 2,519,342. Adsorption Process. C. H. O. Berg to Union Oil Company of California.

In separating a gaseous hydrocarbon mixture containing hydrocarbons of differing mol wts., a solid adsorbent is first contacted with a portion of this mixture containing hydrocarbons of lower mol wts. The heat evolved is dissipated and the original gaseous mixture is then contacted with the adsorbent to cause adsorption of gases of higher mol wt. while desorbing the gases of lower mol wt.

U.S.P. 2,519,343. Adsorption Process and Apparatus. C. H. O. Berg to Union Oil Company of California.

Details are claimed of an apparatus and a process for separating a normally gaseous mixture containing hydrocarbon gases of different mol wts., e.g., a mixture of paraffins and olefins with 1-4 C atoms. An absorption oil and a granular adsorbent, such as charcoal, are used in succession.

U.S.P. 2,519,344. Adsorption Process. C. H. O. Berg to Union Oil Company of California.

Normally gaseous hydrocarbon mixtures which contain thermally sensitive unsaturated hydrocarbons of various mol wts. are separated in a continuous process claimed in detail. The process combines a special rectified absorption operation and a selective adsorption operation to accomplish efficient separation of the thermally sensitive mixture.

U.S.P. 2,519,868. Coloring Material for Lubricating Oils. E. F. Zehmer and O. D. Hunn to Sinclair Refining Company.

A lubricating oil contains 0.25-1 percent by weight of a dyeing additive produced by a specific method from the residue of a heavy gas oil distillate blown with an oxygen-containing gas. A greenish bloom is imparted to the lubricant by the additive.

U.S.P. 2,519,873-4. Adsorption Process and Apparatus. C. H. O. Berg to Union Oil Company of California.

Gaseous mixtures, e.g. such containing valuable hydrocarbons in admixture with flue gases, are separated by selective adsorption on a solid adsorbent. The enriched adsorbent is passed through the upper part of a stripping zone in which it is subjected to countercurrent contact with the stripping gas in the absence of direct heat, and then through the lower part of this zone where it is contacted with the stripping gas in the presence of indirect heat.

U.S.P. 2,520,006. Vapor Liquid Solvent Extraction Process. H. J. Hibschman and R. H. Lafferty to Standard Oil Development Company.

Toluene and xylenes are extracted from mineral oil by introducing liquid phenol into a tower containing vapors of the mineral oil at a point above that of introduction of these vapors. Liquid water is introduced at a point above the phenol introduction in a quantity of 6-41 percent by vol. based upon the volume of hydrocarbons withdrawn as overhead product, to form a constant boiling mixture with these withdrawn hydrocarbons. The amount of introduced water is such that the liquid water passing downwardly in the tower is vaporized before it reaches the bottom.

U.S.P. 2,520,058. Method of Measuring Extent of Oil Saturation of Porous Materials. P. P. Reichertz to Socony-Vacuum Oil Company, Inc.

A process is claimed for determining the characteristics of a porous material. The oil employed for the measurement of the extent of saturation of the porous material contains dissolved a small amount of di-dodecyl ester, tetrahydro orthophthalate of cobalt-60. The intensity of gamma ray emission is measured as a function of the extent of oil saturation of the porous material.

U.S.P. 2,520,391. Liquid-Liquid Contacting. R. A. Findlay to Phillips Petroleum Company.

Details are claimed of an apparatus and a method for carrying out continuous countercurrent contacting of two immiscible liquids of different spe-

Patents

cific gravities, one of these liquids comprising a readily vaporizable component. The method is, for example, useful in the separation of different types of hydrocarbons with the employment of a selective solvent for one of these types.

U.S.P. 2,520,407. Removal of Inorganic Matter from Petroleum Residua. E. M. Hughes to Sun Oil Company.

Petroleum residua containing alkaline naphthenates are mixed at elevated temperature with aqueous sulfuric acid containing 60-67 percent H_2SO_4 by weight. The pressure shall be sufficient to maintain the water in liquid phase. The amount of H_2SO_4 shall only be sufficient to neutralize the residuum. The water is then vaporized from the residuum, whereby salt crystals of relatively large size are formed which are removed.

U.S.P. 2,520,712. Catalytic Purification of Unsaturated Hydrocarbons. H. A. Cheney to Shell Development Company.

A normally gaseous acetylenic hydrocarbon containing an olefin of the same number of C atoms as the acetylenic hydrocarbon is contacted in admixture with chlorine in the vapor phase with solid NaCl at a temperature between —50° and 300° C. The chlorine will be present in an amount substantially equivalent to that required to effect the addition chlorination of the olefin which is selectively chlorinated while the acetylenic hydrocarbon is recovered in a high state of purity.

U.S.P. 2,520,715. Method of Separating Organic Compounds by Means of Urea and Thiourea. L. C. Fetterly to Shell Development Company.

A mixture of petroleum hydrocarbons containing aromatic and non-aromatic hydrocarbons is treated with urea or thiourea in the presence of a solvent for the aromatic fraction of the mixture only, e.g. an alcoholic solution of acetamide. Three phases are formed: a liquid non-aromatic fraction, a liquid solvent phase containing the dissolved aromatic fraction, and a solid crystalline phase comprising the complexes formed between a fraction of the mixture and the urea compound.

U.S.P. 2,520,716. Method of Separating Organic Compounds by Forming Solid Complexes. L. C. Fetterly to Shell Development Company.

The process according to this patent is closely related to that of U.S.P. 2,520,715. The present process is useful in the separation of a mixture of hydrocarbons only some of which are capable of forming solid complexes with urea or thiourea, e.g. for separating normal paraffins from branched chain hydrocarbons. An acid anhydride of the group of SO_3, NO_3 and acetic anhydride is employed here instead of the solvent for an aromatic hydrocarbon fraction.

U.S.P. 2,521,233. Absorption of Nitrogen by Liquid Ammonia. J. W. Latchum, Jr. to Phillips Petroleum Company.

Nitrogen is separated from hydrocarbon gases, e.g. from natural gas, by contacting the gas mixture with liquid ammonia which selectively dissolves the nitrogen.

U.S.P. 2,521,357. Deasphalting Petroleum Oils with Porous Contact Material. R. J. Furnoy to Socony-Vacuum Oil Company, Inc.

An asphalt-bearing petroleum stock is contacted with a substantially microporous particle-form inorganic oxide gel (e.g. a spheroidal siliceous gel) in which the volume of pores having radii greater than 100 Angstrom is less than 30 percent of the total pore volume and the particles are greater than 30 mesh size. The oily constituents of the stock are sorbed into the pores of the gel while asphaltic constituents remain unsorbed. The contact material separated from the unsorbed constituents is then selectively extracted with a paraffinic solvent to remove a deasphalted product of low carbon residue content, whereupon the remainder of sorbed oil is extracted with a polar solvent, e.g. a mixture of methyl ethyl ketone and benzol.

U.S.P. 2,521,415. Stabilization of Organic Compounds. L. Schmerling to Universal Oil Products Company.

Cracked gasoline is stabilized against oxidation by addition of a small amount, preferably 0.0001-0.1 percent by weight, of N-(4-hydroxy/phenyl)-isoindoline.

U.S.P. 2,521,444. Treatment of Isomeric Aromatic Compounds. L. F. Brooke, G. E. Langolis, and A. E. Stickland to California Research Corporation.

A hydrocarbon liquid predominantly consisting of lower dialkyl benzene isomers is extracted at a temperature not above 100° F. with an amount of HF-BF_3 sufficient to form a distinct phase but insufficient to dissolve all the aromatic hydrocarbons present. The HF-BF_3 phase is thereby enriched in the m-dialkyl benzene isomer which is recovered.

U.S.P. 2,522,059. Separation of Hydrocarbons. G. C. Ray and E. O. Box, Jr. to Phillips Petroleum Company.

Methane is separated from its mixture with ethane and/or ethylene by contacting the mixture in the gaseous state with liquid o-anisidine to preferentially dissolve the C_2-hydrocarbons present.

U.S.P. 2,522,426. Method of Extracting Hydrocarbons. J. F. Black to Standard Oil Development Company.

Details are claimed of a continuous method of separating a gaseous hydrocarbon from its gaseous mixture with other hydrocarbons by selective adsorption, particularly by selectively adsorbing a straight-chain gaseous hydrocarbon from its mixture with gaseous branched-chain hydrocarbons. A powdered material of the empirical formula: $4CaO \cdot Al_2O_3 \cdot 4SiO_2$ can, for example, be employed as the adsorbent.

U.S.P. 2,522,429. Apparatus for Handling Oil Field Emulsions. R. C. Buchan to Standard Oil Development Company.

The apparatus claimed is adapted to resolve oil emulsions containing gases.

POLYMERIZATION AND CONVERSION

U.S.P. 2,518,474. Use of Mobile Catalysts in Effecting Chemical Reactions. T. H. Hudson to Phillips Petroleum Company.

Details are claimed of a process for the endothermic conversion (e.g. cracking) of hydrocarbons which process allows careful control by multipoint addition of catalyst, specifically correlated with reaction conditions.

U.S.P. 2,518,546. Cracking with Hydrogen Fluoride Catalyst. R. J. Hengstebeck to Standard Oil Company of Indiana.

Hydrocarbon oil higher boiling than gasoline is converted into gasoline and tar in the presence of a HF catalyst at a temperature of 200-400° F. and at a pressure sufficient to maintain liquid phase conditions during a contact period of 1-60 minutes. Details are claimed.

U.S.P. 2,518,573. Polymerization of 1,3-Dienes in the Presence of Beta-Unsaturated Aliphatic Iodides. G. W. Scott to E. I. du Pont de Nemours & Company.

1,3-butadiene or 2-chloro-1,3-butadiene is polymerized in the presence of 0.1-10 percent of a dihalogen straight chain mono- or di-olefin with not more than 8 C atoms, and containing the nucleus $-C=C-CH-I$, such as 1-iodo-3-chlorobutene-2.

U.S.P. 2,518,583. Catalytic Reactor. C. C. Watson to Universal Oil Products Company.

The construction of a catalytic reactor is claimed which allows the regeneration of catalyst beds in the tubular reactor and is particularly suited for certain hydrocarbon conversion processes.

U.S.P. 2,518,693. Process and Apparatus for Contacting Finely Divided Solids and Gases. C. E. Jahnig to Standard Oil Development Company.

In the catalytic conversion of hydrocarbons, a hydrocarbon stream is passed in gaseous state upwardly through a distributing grid in the lower portion of a lower catalyst contacting zone at such a rate as to maintain a dense turbulent catalyst phase above the grid. An oxygen containing regenerating gas is passed upwardly through a correspondingly arranged grid in an upper zone under corresponding conditions. Contaminated catalyst solids are separated from gases leaving the lower zone and are introduced into the upper zone. Regenerated catalyst is separated from gases leaving the upper zone, and withdrawn regenerated catalyst from this zone is moved downwardly as an aerated column of such height as to provide a pressure at its base greater than that in the lower zone.

U.S.P. 2,518,775. Combined Hydrocarbon Conversion-Hydrocarbon Synthesis Process. J. A. Guyer to Phillips Petroleum Company.

A hydrocarbon feed is cracked at a temperature of 900-1100° F. and a pressure of 1-25 atm. in contact with a catalyst so as to produce gasoline hydrocarbon and deposit 1-10 percent (by weight of catalyst) of carbon on the catalyst. The fouled catalyst is treated at 1100-1800° F. and a pressure up to 25 atm. with a gaseous mixture of steam and oxygen in specified proportions. CO, H_2 and little CO_2 are formed. The regeneration effluent is treated to concentrate the CO and H_2 and to remove CO_2 and H_2O therefrom. The resulting CO/

CATALYTIC POLYMERIZATION
FLUID CATALYTIC CRACKING
Kellogg has engineered and built Combination Units for the following leading refiners:
• Anglo-Iranian Oil Co., Ltd. — 4 units
• Atlantic Refining Co. — 2 units
• British American Oil Co., Ltd. — 2 units
• Cie. Francaise de Raffinage
• Consolidated Refineries, Ltd. — 2 units
• Continental Oil Co. — 2 units
• Imperial Oil Limited
• Magnolia Petroleum Co. — 2 units
• Mitsubishi Oil Co.
• Pan-American Refining Corp. — 11 units
• Socony-Vacuum Oil Co., Inc.
• Standard Oil Company (Indiana) — 2 units
• The Texas Company
• Union Oil Company of California

Kellogg-engineered Combination units have a total capacity of more than a half-million barrels per day!

Yes! Exclusive of lube oil facilities, Kellogg has engineered major refinery Combination units with a total capacity greater than 500,000 BPD ... with more capacity building!

IN this type of processing Kellogg engineers have led the way since the early '30's when they designed the first topping-cracking combination. In the ensuing years, various economical combinations have been built, including distillation, cracking and reforming; distillation and delayed coking; and most recently, distillation and deasphalting in one combination, with another Fluid catalytic cracker-cat poly combination (pictured on reverse side) as a second step.

Common advantages are elimination of intermediate storage, reduction in heat requirements, simplified piping and pumping layouts, and of course easier operation from a common control room. While flexibility is compromised to some extent, refiners facing heavy competition can well afford to look closely at the lower initial cost and lower operating costs inherent in combination processing. The experience gained by Kellogg is unduplicated both in total capacity built and in diversity of types engineered.

COORDINATED, INTEGRATED ENGINEERING IS KEY!

Engineering a true combination unit is not just a case of connecting together two or more individual process units, with instruments in a common location. Rather, it is the integrated engineering of these units into one processing whole. Albeit flexibility to vary individual unit throughputs and yields must be built in, the combination unit, in general, must be designed so that each processing step is exactly balanced with its predecessor.

Only a large engineering organization can put the necessary number of individual specialists to work as a coordinated team on such a project. Only a completely integrated organization is conditioned to the "give and take" that must be achieved between several individual engineering specialists in order to create a completely successful combination unit. (*Illustrated*—south side of the entire floor devoted to piping engineering at Kellogg headquarters).

IT TAKES ALL SEVEN TO PRODUCE GREATER EARNING POWER...

1 THE DEVELOPMENT "TOOLS"
—laboratories, pilot plants and recognized specialists to prove and improve processing and equipment ideas.

2 PROCESS ENGINEERING
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3 SPECIALISTS IN EVERY PHASE
of design engineering due to the completeness of Kellogg's engineering staff.

4 SPECIALIZED BUYERS
backed by the cumulative buying power of the largest company in the business.

5 COMPLETE FABRICATING FACILITIES
to make schedule deadlines and to develop workable "firsts" in refinery equipment.

6. CONSTRUCTION KNOW-HOW
acquired in completing hundreds of major jobs plus a more important factor . . . constant and close integration with the design engineering staff. This day-by-day liaison begins when the first pencil is put to paper by a design engineer. Further, it starts at the same time with the Schedules Engineer as well, continuing as each piece of equipment and each length of pipe is ordered. Thus, when Kellogg construction engineers take the field, they not only know from the plans what they are about to undertake, but the field construction methods (down even to guy derrick lifts) and timetable have all been agreed upon in detail *in advance*.

7 PRACTICAL OPERATING COUNSEL
on all design and construction, achieved through practical operating men working as an integral part of the company.

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Patents

H_2 mixture is treated with a Fischer-Tropsch catalyst at a temperature of 340-700° F. and a pressure of 1-20 atm. Gasoline and heavier hydrocarbons are produced. This gasoline is blended with that obtained in the cracking operation. The heavier hydrocarbon fraction can be recycled to the cracking step.

U.S.P. 2,519,034. Low Temperature Polymerization of Mixed Olefins with Al_2ClBr_5 Catalyst. N. M. Elmore and D. W. Young to Standard Oil Development Company.

A C_4 cut containing isobutylene, n-butylenes, isobutane and n-butane is mixed with a hydrocarbon-soluble Al_2ClBr_5 catalyst dissolved in butane, and the hydrocarbon mixture is polymerized at a temperature of +6° to —164° C. A copolymer of isobutylene and n-butenes is obtained.

U.S.P. Re. 23,254. Manufacture of Isobutylene. W. C. Offutt to Gulf Research & Development Company.

A liquid polymer comprising essentially isobutylene dimer is depolymerized by means of a synthetic surface active silica-alumina cracking catalyst of rated activity at a temperature of 450-750° F.

U.S.P. 2,519,481. Temperature Control of Chemical Reactions. W. L. Kubie and M. Mattikow to Benjamin Clayton, Houston, Tex. (Refining Unincorp.).

In controlling the temperature of exothermic chemical reactions, e.g. hydrocarbon conversions, by passing the fluid material to be reacted through the reaction zone in intimate contact with solid particles of electrically conductive material, heat is extracted from this zone with a cooling medium at a greater rate than heat is generated by the reaction. The solid particles are subjected in the reaction zone to an alternating magnetic field for generating heat in the particles, and this field is varied to control the amount of heat generated in the particles and maintain a desired temperature.

U.S.P. 2,519,791. Catalyzed Ethylene Polymerizations. M. J. Roedel to E. I. du Pont de Nemours & Company.

Ethylene is homopolymerized at a temperature of 60-400° C. and under a pressure of 2-3000 atm. in the presence of 0.0005-5 percent of di(tert. butyl) peroxide and in the presence of a reaction medium which consists wholly of water. The film of the resulting polymer has a tensile strength of about 3600 psi. and an elongation at break of about 475 percent.

U.S.P. 2,519,955. Production of Hydrocarbon-Oxygen Mixtures. P. H. Deming to Shell Development Company.

Details are claimed of a method of producing hydrocarbon-oxygen mixtures e.g. methane-oxygen mixtures suitable for the preparation of synthesis gas.

U.S.P. 2,520,146. Art of Producing Hydrocarbon Vapors. E. J. Houdry to Houdry Process Corporation.

A granular contact mass is contacted under conversion conditions with atomized particles of liquid hydrocarbon material uniformly suspended in a stream of vapor. Details are claimed of the

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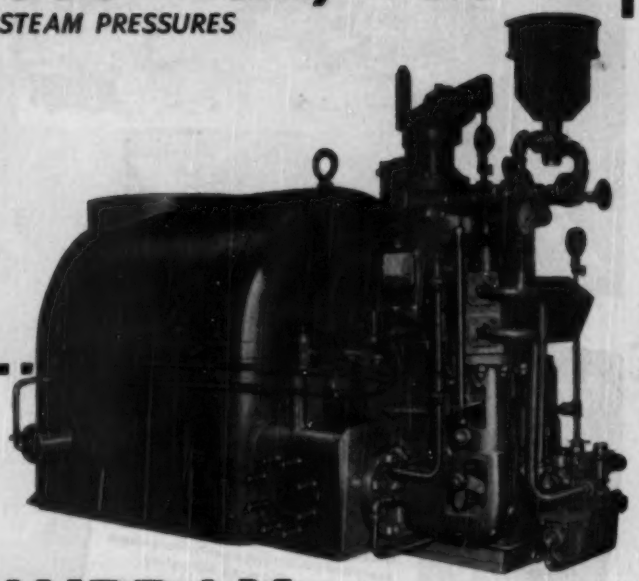

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Patents

method of mixing the vapors with the atomized liquid. A turbulent swirling mass of the vapor is created and the atomized liquid is then injected into it.

U.S.P. 2,520,339. Araliphatic Azo Catalysts for Addition Polymerization. J. A. Robertson to E. I. du Pont de Nemours & Company.

In the addition polymerization of ethylenically unsaturated compounds, such as ethylene itself, a compound of the formula Ar-CHR-N = N-CHR-Ar wherein Ar is a monovalent aromatic radical with the free valence attached to the ar. ring and R is a C_1 or C_2 hydrocarbon radical, is employed as the catalyst.

U.S.P. 2,520,717. Contacting. W. A. Hagerbaumer to Socony-Vacuum Oil Company, Inc.

A granular solid material is heated by passing it downwardly as a compact bed through a heating zone while injecting a mixture of gaseous fuel and air insufficient for the combustion thereof into the bed at a plurality of primary points in the lower portion of the bed. Additional air of combustion is injected as separate increments on at least one level above the primary points. Details for the injection of these increments of air are claimed.

U.S.P. 2,520,983. Fluidized Stripping and Renegeration of Spent Hydrocarbon Conversion Catalyst. M. J. Wilcox to Sinclair Refining Company.

Details are claimed of a fluid catalyst hydrocarbon conversion process in which spent catalyst is stripped with a gaseous stripping medium and is then decarbonized by contact with air. The stripping zone and the regenerating zone are combined in one single chamber. The hot combustion gases obtained in the lower regeneration zone of the chamber pass upwardly through the spent catalyst in the upper stripping zone.

U.S.P. 2,521,195. Fluidized Solids Conversion System. H. K. Wheeler, Jr., to Standard Oil Company of Indiana.

A system is claimed for contacting fluidized solids with gases or vapors. The system makes possible the transfer of solids from one zone to another independent of the bulk density of the fluidized solids by regulating gas velocities in the transfer zones themselves.

U.S.P. 2,521,359. Copolymers of Cyclopentadiene. J. D. Garber to Standard Oil Development Company.

A homogeneous copolymer of a cyclopentadiene and a mono-olefin, such as isobutylene, is prepared by low-temperature polymerization in the presence of a Friedel-Crafts metal halide catalyst of a mixture containing an excess of the mono-olefin over that required for the production of a copolymer containing the desired major amount of cyclopentadiene. Details of the process are claimed. Resins readily soluble in a variety of solvents are obtained.

U.S.P. 2,521,494. Method of Making Lower Polymers of Alkenyl Aromatic Compounds. G. C. Wiggins to The Dow Chemical Company.

An alkenyl aromatic hydrocarbon with at least 9 C atoms having the formula

Patents

R-C = CH_2, wherein R is an aryl radical

R'

of the benzene series and R' is hydrogen or an alkyl radical with less than 4 C atoms, is heated together with at least 0.5 of its mol equivalent of HCl at 130-200° C. The resulting polymers lower than tetramers are recovered from the reaction mixture by distillation.

U.S.P. 2,521,514. Phosphoric Acid Polymerization of Thiophene Compounds. H. D. Hartough and S. L. Meisel to Socony-Vacuum Oil Company, Inc.

Thiophene or alkylthiophenes are contacted at a temperature of not less than 50° F. with concentrated H_3PO_4 as a catalyst. Polymers of the thiophene compound are obtained.

U.S.P. 2,521,675. Interpolymerization of Styrene, Alpha-Methylstyrene, and Oxidized Soyabean Oil. H. M. Hoogsteen to The Dow Chemical Company.

Air-blown soyabean oil (20-80 parts by weight) containing 16.3-18.5 percent of chemically combined oxygen is polymerized at a temperature of 100-300° C. with a total of 80-20 parts of styrene and alpha-methylstyrene in the presence of a metal salt paint drier, such as Co or Mn naphthenate, dissolved in the polymerization mixture. The alpha-methylstyrene shall correspond to 10-40 percent of the combined styrene compound mixture.

U.S.P. 2,521,939. Catalytic Polymerization of Olefins with Hydrogen Bromide Promoter. D. J. Oriolo to Socony-Vacuum Oil Company, Inc.

In the continuous polymerization of propylene by continuously passing streams of propylene, $AlBr_3$ dissolved in a non-polymerizing hydrocarbon, and of HBr-promoter into a polymerization zone, the HBr stream is first distilled to remove $FeBr_3$ therefrom.

U.S.P. 2,521,940. Removal of Catalyst from Olefin Polymer Product. D. J. Oriolo to Socony-Vacuum Oil Company, Inc.

In the olefin polymerization catalyzed with a metal halide catalyst promoted by hydrogen halide, the catalyst and the promoter are removed from the resulting polymer by mixing it with an alcohol, such as propyl or isopropyl alcohol, and then admixing water. After removal of the alcohol and water, the product is washed with additional water.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,518,688. Process for Producing Acetylene. R. L. Hasche to Tennessee Eastman Corporation.

An acetylene containing gas is produced from fluidized hydrocarbons with at least 2 C atoms by first heating these hydrocarbons at subatmospheric pressure to vaporize them and produce unsaturated hydrocarbons convertible into acetylene. The resultant gas is heated to a higher temperature to effect this conversion, after an inert diluent gas has been injected into the reaction mixture

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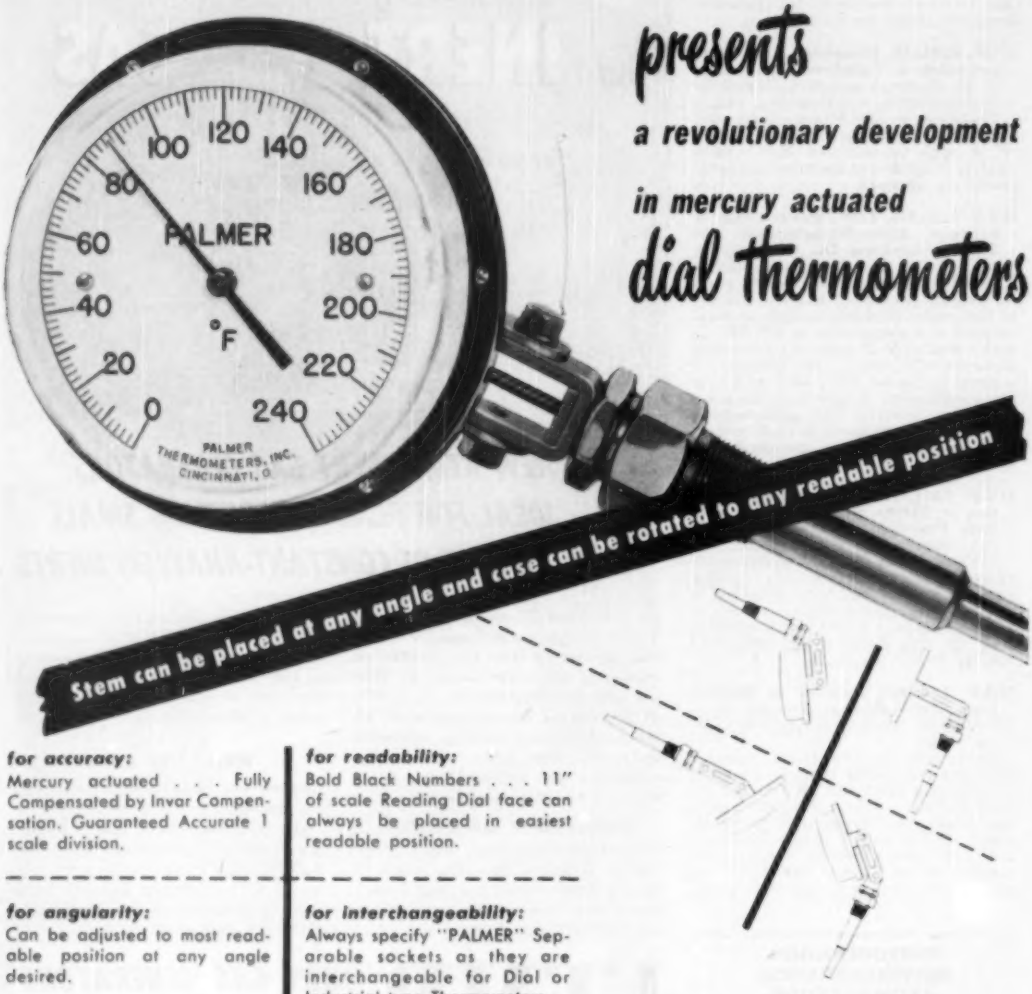
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of the first stage, so that the total pressure of the mixture is raised to atmospheric.

U.S.P. 2,519,719. Catalytic Processes for Producing Styrenes and the like from Diaryl Paraffins. M. G. Sturrock and T. Lawe to Dominion Tar & Chemical Company, Ltd.

Paraffins with at least 2 C atoms in the paraffin chain and 2 aryl substituents attached to the same C atom of this chain, e.g. asymmetric diaryl-ethanes, are contacted at a temperature of at least 350° C. with a hydrated aluminum silicate catalyst in the form of particles passing through an 80 mesh screen and forming a coating on a non-porous carrier. Mononuclear aromatic compounds, such as styrenes, are produced.

U.S.P. 2,520,925. Generation of Synthesis Gas. P. W. Garbo to Hydrocarbon Research, Inc.

Separate streams of hydrocarbon gas and oxygen are passed through spaced and opposed porous barriers into the intervening free space forming a generation zone which is maintained at elevated reaction temperature. A mixture of CO and H_2 is produced.

U.S.P. 2,521,538. Process for Synthesis of Hydrocarbons and the like. H. V. Rees to Texaco Development Corporation.

In a Fischer-Tropsch synthesis, the stationary catalyst is deposited in a continuous permeable layer of a thickness of 1/64-1 inch on one surface of a relatively thin porous vertical supporting wall. The CO/H_2 mixture is passed under synthesis conditions first through the catalyst layer and then through the porous wall. A liquid coolant is flowed in a thin stream over the uncovered surface of the porous wall and out of contact with the catalyst.

U.S.P. 2,522,468. Production of Synthesis Gas. W. M. Smith to Standard Oil Development Company.

A mixture of methane, steam and CO_2 is continuously charged to a reforming zone maintained at a temperature of 1300-1800° F. and containing an iron or nickel catalyst on a carrier. The gaseous mixture shall be such that there is an excess of oxygen of 50-100 percent over that satisfying the equation: $CH_4 + CO_2 \rightarrow 2CO + 2H_2$. A synthesis gas containing equal volumes of CO and H_2 is continuously produced.

DESULFURIZATION

U.S.P. 2,519,587. Desulfurizing Hydrocarbon Oils. D. A. McCaulay and A. P. Lien to Standard Oil Company of Indiana.

Details are claimed of a process for removing hydrocarbon disulfide from a hydrocarbon oil by contacting the oil in a plurality of stages with conc. HF in the presence of certain amounts of olefin, so that a HF-soluble sulfur-containing reaction product between the disulfide and the olefin is formed in each stage and can be removed.

U.S.P. 2,521,761. Method of Desulfurizing Crude Oil. B. J. Strawinski to

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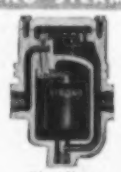
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Texaco Development Company.

Sulphur containing crude oil, topped crude fractions thereof, or partially treated or refined oils are subjected for reducing their sulfur content to the action of one or more carbon-consuming and sulfur-consuming micro-organisms in the presence of a monosaccharide or polysaccharide, such as dextrose, capable of diverting the carbon-consuming action of the microorganisms from the carbon content of the oil.

U.S.P. 2,522,065. Catalytic Desulfurization and Reforming Process. G. H. Short to Phillips Petroleum Company.

Details are claimed of a process for desulfurizing and reforming hydrocarbon materials by means of granular bauxite. A mixture of C_6- and lighter hydrocarbons is first desulfurized by the catalyst under suitable conditions in the presence of oxygen, sulfur being thus deposited on the bauxite catalyst. This deposited sulfur is then utilized as a hydrogen acceptor in a subsequent desulfurizing and reforming step for the hydrocarbon material which is fractionated thereafter with recovery of desulfurized gasoline and removal of H_2S from the fraction containing C_6- and lighter hydrocarbons. This fraction is then employed for pretreating the bauxite catalyst.

HEAVY OILS AND WAXES

U.S.P. 2,518,529. Process for Producing Synthetic Lubricants. R. B. de Casson and L. Hemmer to Soc. an. Standard Francaise des Petroles.

A lubricant is produced by simultaneously alkylating and polymerizing specific proportions of benzene and a cracked distillate in the presence of $AlCl_3$ under specific conditions, and further treating the reaction product.

U.S.P. 2,521,395. Aluminum Soap Greases. A. J. Morway and A. Beerbower to Standard Oil Development Company.

A lubricating grease consists of 91-93 percent by weight of mineral lubricating oil, 6-7 percent aluminum stearate, 0.6-1.2 percent hydrogenated substantially saturated fish oil acids with 12-22 C atoms, and 0.6-0.7 percent iso-octyl phenol.

U.S.P. 2,521,438. Grease Composition. J. C. Zimmer and A. J. Morway to Standard Oil Development Company.

A low temperature grease consists of 20-40 percent by weight of mineral lubricating oil, 45-65 percent of an ester of the formula $COOR_1(R)COOR_2$ wherein R is a bivalent aliphatic hydrocarbon radical and R_1 and R_2 are branched chain hydrocarbon radicals, e.g. di-2-ethylhexyl sebacate, 5-30 percent of an alkali or alkaline earth metal soap, and 0.1-5 percent of an amphoteric metal soap as a stabilizer.

U.S.P. 2,522,312. Antioxidants for Mineral Oil Lubricants and Compositions Containing the Same. H. G. Smith and T. L. Cantrell to Gulf Oil Corporation.

A lubricant composition comprises a major amount of mineral lubricating oil and a minor amount of a non-resinous condensation product of 1 mol of triphenylguanidine with 4-9 mols of N-

dimethylaniline and 4-9 mols of formaldehyde. This condensation product is obtained by a specific process. Oxidative deterioration of the oil is inhibited by the additive.

U.S.P. 2,522,455. Mineral Oil Containing a Copolymer of an Aliphatic Monoolefin and Dihydronaphthalene. E. Lieber to Standard Oil Development Company.

A mineral lubricating oil contains dissolved therein 0.1-10 percent by weight of a copolymer prepared from 80-99 parts by weight of an aliphatic monoolefin having 3-5 C atoms, e.g. isobutylene, and 20-1 parts of dihydronaphthalene at a temperature below 0° C. in the presence of a Friedel-Crafts catalyst. The copolymer has a mol wt. of 2,000-30,000. The additive improves the viscosity index of the oil.

U.S.P. 2,522,460. Lubricating Grease Composition. A. J. Moorway and A. Beerbower to Standard Oil Development Company.

A lubricating composition consists of 66-94 percent mineral oil, 5-30 percent of a metal soap of fats or fatty acids, and 2-4 percent of a modified channel carbon black having a pH of about 9, a particle size of 20-100 millimicrons, and a structure index of about 200. The carbon black inhibits oxidative deterioration of the composition and tends to form stable colloidal or grease-like structures with the oil.

U.S.P. 2,522,476. Compositions Containing and Process for Preparing Stabilized Unsaturated Fatty Acids. J. I. Wasson to Standard Oil Development Company.

A mineral base lubricating oil contains 0.1-10 percent of the reaction product of a C_{18} unsaturated fatty acid partial ester of a polyhydric alcohol (e.g. of pentaerythritol mono oleate) with an alkyl mercaptain with 6-20 C atoms obtained by heating the components to 50-325° F. in the presence of a Friedel-Crafts catalyst. The additive, which contains the mercaptan attached to a double bond of the fatty acid radical, has pour point depressing properties.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,518,714. Four-Component Alumina Base Catalyst and its Preparation. R. L. Parker, Jr., and H. C. Huffman to Union Oil Company of California.

A catalyst for hydrocarbon conversions consists of an active alumina gel carrier containing 0.5-15 percent of an oxide of Si, Ti, or Zr precipitated thereon, 1-15 percent of beryllia, and 1-15 percent of an oxide of a metal of group VI B, e.g. Cr or Mo.

U.S.P. 2,519,622. Protection of High Surface Xerogels, R. C. Archibald and F. T. Eggertsen to Shell Development Company.

In the steaming of microporous mineral xerogel, such as a silica-alumina cracking catalyst, an org. nitrogen base, e.g. a tert. aliphatic amine, is added to

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the steam to reduce the loss of surface of the xerogel during steaming.

U.S.P. 2,520,947. Recovery of Hydrogen Halides. M. P. Matuszak to Phillips Petroleum Company.

Hydrogen halide, particularly HF, is recovered from a mixture with hydrocarbons, e.g. C_3—C_5 paraffins, by subjecting the mixture in gas phase to absorption in a glycol or a substituted glycol having a substituent radical for one hydroxylic hydrogen. The hydrogen halide is selectively absorbed and then stripped from the absorbent.

U.S.P. 2,521,431. Activation of Friedel-Crafts Catalyst. D. C. Walsh, Jr., and H. G. Schutze to Standard Oil Development Company.

A mixture of anhydrous tert. olefin and diolefin is polymerized at a temperature of —50° to —175° F. in the presence of a Friedel-Crafts catalyst dissolved in alkyl halide and containing 0.01-4 mols of water (based on the catalyst). The reaction is enhanced by this addition of water.

U.S.P. 2,521,432. Activation of Friedel-Crafts Catalysts for Polymerization of Olefins. D. C. Walsh, Jr., and H. G. Schutze to Standard Oil Development Company.

The process according to this patent differs from that of U. S. patent 2,521,-431 essentially only in that an amount of 0.001-1.5 mols (based on the catalyst) of a tert. olefin, such as isobutylene, is added to the catalyst solution in addition to the water.

U.S.P. 2,522,354. Gas-Solid Contact Apparatus. F. C. Fahnestock to Socony-Vacuum Oil Company, Inc.

An apparatus is claimed for contacting and reacting gases and solids, e.g. for regenerating catalysts. Fluid reactants are conducted into or withdrawn from a compact mass of contact material without substantial entrainment of contact material in the gaseous streams.

PETROCHEMICALS

U.S.P. 2,517,732. Preparation of Ketones by Catalytic Reaction of Ethylene and Aldehydes. C. H. Stiteler and J. R. Little to U. S. Rubber Company.

A non-aqueous mixture of 1 part of ethylene and 1.36 parts of acetaldehyde is heated in the presence of dibenzoyl peroxide at a temperature of 80-84° C. and specific increased pressure for about 20 hours. Methyl ethyl ketone, methyl n-butyl ketone, and methyl n-hexyl ketone are simultaneously produced.

U.S.P. 2,518,754. Process of Synthesizing Aliphatic Amines. A. Clark to Phillips Petroleum Company.

A gaseous mixture containing 2-20 percent NH_3 and H_2 and CO in a vol ratio of 2:1 to 1:1 is contacted with a hydrogenation catalyst containing iron as the only metallic component at a temperature of 240-320° C. and a pressure of 1-200 atm. Aliphatic amines with 1-12 C atoms are formed.

U.S.P. 2,519,199. Synthesis of Vinyl Fluorides. L. F. Salisbury to E. I. du Pont de Nemours & Company.

An acetylenic hydrocarbon is contacted in the vapor phase in admixture with HF with a basic mercury nitrate catalyst supported on an inert carrier, such as charcoal, at a temperature of 20-100° C. A vinyl fluoride, e.g. fluoroprene, is produced. The catalyst is prepared in a manner claimed in detail.

U.S.P. 2,519,309. Preparation of Oxygenated Naphthenes. W. I. Denton to Socony-Vacuum Oil Company, Inc.

A naphthenic hydrocarbon fraction containing at least 75 percent of alkyl-substituted, completely saturated naphthenes boiling within a range of 75° F. with an initial b.p. of 250° F. is oxidized in the vapor phase with 0.1-4 mols of oxygen in the absence of a catalyst at a temperature of 250-600° F.

U.S.P. 2,519,576. Production of Arylindans. V. N. Ipatieff and H. Pines to Universal Oil Products Company.

An alkylated aromatic hydrocarbon having two hydrocarbon groups in p-position and having as one substituent an alkyl group containing only one hydrogen atom joining to the C atom combined with the aromatic ring and having a hydrogen atom combined with a C atom of the ring which is adjacent to the C atom of the ring which is combined with said alkyl group is reacted with a tert. alkyl phenol at a hydrogen transfer temperature of —30° to 100° C. in the presence of an acid-acting catalyst, e.g. a mineral acid. Indan hydrocarbons are produced.

U.S.P. 2,519,577. Production of Aryl Indan Hydrocarbons. V. N. Ipatieff and H. Pines to Universal Oil Products Company.

The process according to this patent differs from that of U. S. patent 2,519,-576 only in that a branched chain olefin is reacted with a meta-dialkylated aromatic hydrocarbon having as one substituent an alkyl group of the type described in said patent. Arylindan hydrocarbons are obtained.

U.S.P. 2,519,586. Conversion of Olefins and Disulfides. D. A. McCaulay and A. P. Lien to Standard Oil Company of Indiana.

An olefinic hydrocarbon, e.g. a non-tert. mono-olefinic hydrocarbon is reacted with an organic disulfide, e.g. a compound of the formula R_1SSR_2 wherein R_1 and R_2 are hydrocarbon radicals, in the presence of an acidic condensation catalyst. Dithioethers are produced.

U.S.P. 2,519,754. Manufacture of Ethylene Glycol Esters. W. F. Gresham and C. E. Schweitzer to E. I. du Pont de Nemours & Company.

Ethylene and acetic acid are reacted with an oxidizing gas at a temperature of 100-250° C. in the presence of HBr or an aliphatic organic bromide capable of generating free HBr at these temperatures and under oxidizing conditions. Ethylene glycol diacetate is obtained.

U.S.P. 2,519,930. Recovering Sulfonates of Oil-Soluble Sulfonic Acids from Acid-Treated Hydrocarbon Oils. G. Riethof, C. W. Montgomery, and G. P. Brown, Jr., to Gulf Research & Development Company.

In the sulfonation of hydrocarbon oil with formation of an acid oil layer and a sulfonating agent layer, the oil layer is neutralized with an alkylolamine incompletely miscible with the neutralized oil and having a density greater than that of this oil, e.g. monoethanolamine. A sufficient excess of the alkylolamine is employed to dissolve the resulting sulfonic acid salts and form a liquid alkylolamine layer which is separated.

U.S.P. 2,520,181. Process of Preparing Amines and Nitriles from Ammonia and Olefins. J. W. Teter and L. E. Olson to Sinclair Refining Company.

In the production of nitrogen-containing products from olefins and ammonia, (e.g. by heat treatment at 400-720° F.), a catalyst is employed which consists of a reduced mixture of cobalt oxide and zinc oxide in the molar proportions of Co to Zn between 1:2 and 2:1, said mixture being supported on an inert carrier. The catalyst may also include reduced nickel oxide.

U.S.P. Re. 23,265. Catalytic Process for the Preparation of Acrylic Acid Nitrile. P. Kurtz to The U. S. Attorney General.

Acetylene and HCN are contacted with an aqueous acid reacting solution of CuCl containing an ammonium, amine, or alkali salt. Acrylic acid nitrile is produced.

U.S.P. 2,521,429. Thiophene Production from Diclefin, Hydrogen Sulfide, and Alumina. E. F. Wadley to Standard Oil Development Company.

A mixture of conjugated diolefin, such as butadiene-1,3, and H_2S is heated to 900-1100° F. and then passed over an activated Al_2O_3 catalyst. Thiophene or its homologues are produced.

U.S.P. 2,521,436. Fatty Acid Production in Hydrocarbon Synthesis. C. H. Worsham and C. H. Holder to Standard Oil Development Company.

A synthesis gas containing 1-1.3 vols. H_2 per vol of CO is fed into a dense fluidized bed of finely divided iron-containing catalyst. A total pressure of 500-700 psi., a hydrogen partial pressure of 150-300 psi., and a temperature of 600-700° F. are maintained in the reaction zone. Fresh gas is fed to this zone at the rate of 5-50 cubic feet per pound of catalyst per hour. A moderate H_2 to CO conversion level of 92-93 percent is maintained. Withdrawn tail gas is recycled in the ratio of 1-2 vols per vol. of fresh feed. A CO_2 concentration of 25-40 percent is maintained in the feed gas. The resulting product contains substantial quantities of fatty acids.

U.S.P. 2,521,466. Process for Producing Phthalic Anhydride from Ortho-Xylene Concentrates and Naphthalene. I. E. Levine to California Research Corporation.

A mixture of naphthalene and alkyl benzenes containing 70-95 percent by vol. of o-dialkyl benzenes with 1-3 C atoms in each alkyl group and 30-5 percent of isomeric m- and p-dialkyl benzenes is treated to oxidize the naphthalene and o-dialkyl benzenes to phthalic anhydride and simultaneously selectively over-oxidize the m- and p-isomers at least to the point of ring rupture by passing the vaporized mixture over a vanadium oxide catalyst at a temperature of 800-1175° F.

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ANACONDA Duplex Heat Exchanger Tubes on request are supplied with the ends of the external tube cut back to receive ferrules for rolling into the tube sheet. Ferrules can also be supplied.

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SAN FRANCISCO 7 440 Brannon St.

In Canada: Mundet Cork & Insulation, Ltd. 35 Booth Ave., Toronto

Patents

U.S.P. 2,521,626. Process for Fluorinating Hydrocarbons. A. F. Benning to the U. S. Atomic Energy Commission.

Details are claimed of a method of fluorinating a petroleum lubricating oil with a minimum of scission polymerization, and formation of few fluorinolysis products. CoF_3, AgF_3, and MnF_3 are employed as fluorinating agents.

U.S.P. 2,522,355. Thiphene Condensation Products. C. F. Feasley to Socony-Vacuum Oil Company, Inc.

Thiophene is reacted with an aldehyde, such as formaldehyde, in the mol ratio of 1:1 to 4 at temperatures of 165-350° F. in the presence of activated clay, fresh burnt Attapulgus clay, silica gel, synthetic alumina-silica gel with 7-15 percent alumina, or base exchange alumina-silica gels as the sole essential condensing agent. Resinous products are obtained.

ALKYLATION

U.S.P. 2,519,072. Noncatalytic Alkylation Under High Pressure. F. R. Russell to Standard Oil Development Company.

A mixture of olefins and isoparaffins containing about 30 percent of olefins is subjected to a temperature above 300° F. and a pressure over 100,000 psi. Hydrocarbons of higher mol wt. are obtained.

U.S.P. 2,519,099. Preparation of Alkyl-Aromatic Compounds. G. C. Bailey and J. A. Reid to Phillips Petroleum Company.

A polymerizable aliphatic olefin and a mononuclear alkylatable aromatic hydrocarbon are contacted in the presence of a catalyst comprising Ni_2O_3 and silica-alumina under polymerization and alkylation conditions. An alkyl-aromatic hydrocarbon is produced in which the alkyl radical has a greater number of C atoms than the original aliphatic olefin. Sec. butyl benzene is, for example, obtained by the process from ethylene and benzene.

U.S.P. 2,521,344. Alkylation of Aromatic Hydrocarbons. C. A. Cohen and C. W. Muessig to Standard Oil Development Company.

Aromatic hydrocarbons are contacted with C_{10}-C_{18}-olefins at a temperature of 0-80° C. in the presence of an $AlCl_3$-chloroform complex catalyst in which the mol ratio of $AlCl_3$ to chloroform is 2:1. Monoalkylated aromatics are obtained, e.g. dodecyl toluene from toluene and a C_{12}-olefin, such as a propylene polymer.

CRACKING AND REFORMING

U.S.P. 2,519,696. Tube Cracking Furnace. J. B. Orr, Jr.

The construction is claimed of an apparatus for continuously thermally converting gaseous or fluid hydrocarbon in a multiplicity of cracking tubes.

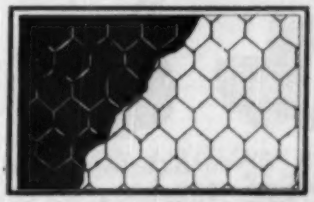
U.S.P. 2,520,149. Process for Producing

What's wrong with this picture?

This man has buried chicken wire reinforcement under the insulating cement on the outdoor tank shown above. Now he's troweling a weatherproofing finish over the cement. While this method provides a smooth and attractive surface, the reinforcing does only half its job. It strengthens the cement, but it offers no grip to the weatherproofing finish that is being applied over it.

The wire should be applied after the cement has been troweled on. Then the wire will serve as added support for the cement and will bond Armstrong's Insulmastic finish firmly to the surface.

In most heat insulation jobs, a smooth, neat finish is a good indication of expert, efficient application. This is one exception. When an Insulmastic finish is applied to large areas, a slightly "waffled" appearance of the completed job indicates a strong bond and promises longer service.



NOT SO SMOOTH, but much stronger, the right application of chicken wire reinforces both the asbestos cement and plastic weatherproofing finish.

For the money you spend on a heat insulation contract, you have a right to expect close attention to every detail of the job. All the men in the Armstrong organization—engineers, superintendents, foremen, and workmen—take pride in handling each detail in the right way. They know how important this is to the performance of the insulation and to our reputation for good workmanship. The next time you buy a heat insulation contract, find out how this extra care gives you more for your money. Call the engineer in the Armstrong office nearest you or write direct to Armstrong Cork Company, 7511 Maple Avenue, Lancaster, Pennsylvania.

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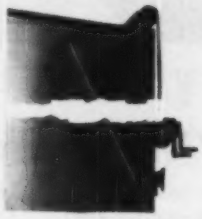
TYPE "BE" VENT UNITS consist of a V-113 Vent Valve with snuffer, mounted on a Type "E" "Extensible" Bank Flame Arrestor. 2" to 10" sizes. Unsurpassed for efficiency and reliability.



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V-100 EMERGENCY PRESSURE RELIEF VENTS provide instant relief for excessive internal pressures, resulting from exposure fires, etc. Furnished in 6", 8", 10", 15¼" and 20¼" sizes.

V-100 STILL TYPE VALVES combine vacuum and pressure relief in a single valve. 3", 4" and 6" sizes. Pressure settings from 2 to 25 lbs. per sq. inch. Vacuum settings from 1 oz. to 10 oz. Temperatures up to 600° F.

V-114 INTERNAL TANK VALVES are provided with a fusible link that melts when subjected to fire, closing the valve instantly, and cutting off the flow from the tank. 3", 4", 6", 8", 10", 12" and 16" sizes.

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Patents

Olefins. W. O. Keeling to Koppers Company, Inc.

Details are claimed of a process for converting low boiling hydrocarbons into ethylene, propylene, and similar olefins by thermal cracking. The vaporized hydrocarbons are first superheated by indirect heat exchange. They are maintained at cracking temperature for a period of time sufficient to initiate rupture of the carbon to carbon linkage and are then further treated in a reaction chamber after admixing a heat carrier gas of higher temperature.

U.S.P. 2,521,757. Conversion of Heavy Hydrocarbon Materials. E. A. Smith to Houdry Process Corporation.

In a catalytic cracking process with circulating and regenerating fluent solid catalyst particles passing through upflow and downflow paths, production of high yields of gasoline, and formation of catalyst fines by abrasion, the separated fines are calcined in the presence of steam to reduce their activity. A minor amount of the calcined fines is mixed with a high boiling hydrocarbon charge stock having a dew point above the cracking temperature of 800-1050° F. The suspension formed is heated under liquid phase conditions until said dew point is substantially lowered and less than 5 percent by vol. of this charge stock is converted to gas and gasoline. By then flash distilling the suspension, a liquid residue containing the fines is formed and a vaporous hydrocarbon fraction which is directly passed to the cracking zone.

Control Valve Dimensions Are Standardized by ISA

Most control valve manufacturers are now able to supply flanged control valves conforming to uniform face-to-face dimensions agreed on by the National Steam Specialty Club and the Instrument Society of America. The recommended specifications are shown in the accompanying table.

Standardization results from the work of a sub-committee of the ISA Recommended Practices Committee, appointed April 23, 1947. The sub-committee, designated as ISA-PR-4 and headed by W. H. Fortney of Humble Oil & Refining Company, sent questionnaires to user industries to determine the need for standardization. The first question was: "Are you of the opinion that the various manufacturers of control valves should get together and standardize on the face-to-face dimensions of their valves?" The 18 instrument engineers who answered this first instrument question were unanimous in the affirmative. The engineers in the Gulf Coast area who answered were asked to become the RP-4 Sub-Committee membership.

The National Steam Specialty Club was selected as the group in the best position to have a maximum representation of control valve manufacturers. This organization, at its May 18, 1949, meeting reached satisfactory dimensional values and notified the ISA Recommended Practices Committee that the release date had been set as June 1, 1950. In this recommendation there was covered the face-to-face body dimensions for flanged end valves of both cast iron and steel through 400# flange ratings.

Reprint Policy

A change has been made in PETROLEUM REFINER's policy with regard to small, individual orders for reprints of its articles. Since January 1 a charge of 50 cents per copy has been made WHEN REPRINTS ARE AVAILABLE. This will continue.

The charge for tear sheets of a particular article, effective April 1, has been reduced to 25 cents.

Cash or Company requisitions should accompany all such "individual" orders.

This change does not affect the price for quantity orders of reprints (starting at 100 orders) which will be quoted upon request.

Sizes to be included were ½ inch through 8 inches. Not included because of infrequent use were sizes 1¼ through 5 inches.

In the summer of 1948, correspondence was received from the British Standard Institute indicating that they had an industry committee working on the same problem and indicating their desire to coordinate their efforts with the American user and industry group. The British organization has subsequently been represented at RP Committee meetings.

The uniform face-to-face dimensions are now being considered for official endorsement by the ISA Recommended Practices Committee, and it is likely that they will be accepted without change.

Uniform Face-to-Face Dimensions for Flanged Control Valve Bodies

Pipe Size Inches	125 Psi. Iron[1] 150 Psi. Steel[1]	250 Psi. Iron[2] 300 Psi. Steel[2]	600 Psi. Steel[3]
½	...	7½	8
¾	...	7½	8½
1	7¼	7¾	8½
1½	8¾	9¼	9½
2	10	10½	11¼
2½	10⅝	11½	12¼
3	11⅞	12½	13½
4	13½	14½	15½
6	17¾	18½	20
8	21½	22½	24

[1] Cast iron bodies with 125 Psi. ASA B16A-1939 flanges, and steel bodies with 150 Psi. raised face ASA-1B16E-1939 flanges.

[2] Cast iron bodies with 250 Psi. ASA B16B-1944 flanges, and steel bodies with 300 Psi. raised face B16E-1939 flanges.

[3] Steel bodies with 600 Psi. raised face ASA B16E-1939 flanges

World Crude Runs to Stills Decrease in Month Period

World crude runs to stills decreased an average of 90,000 barrels per day in April, according to the Bureau of Mines monthly report on oil statistics. The decline from the March volume was due mainly to a decrease in the U. S. average from 5,336,000 barrels per day in March to 5,193,000 barrels daily in April.

A drop in the daily average for crude runs was also recorded by Mexico (13,000 barrels), France (9000 barrels), Italy and Trieste (10,000 barrels), and Iran (10,000 barrels).

Increased daily runs were marked up by Canada (15,000 barrels), Netherland Antilles (1000 barrels), Netherlands (7000 barrels), Bahrein Island-Saudi Arabia (14,000 barrels), and British Borneo-Indonesia (13,000 barrels).

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WILMINGTON, DELAWARE

Write for Bulletin 80-130

This lead pipe was exposed to Dilute HNO_3 for 2 weeks.

Pipe corroded half-way through, unsuitable for further service.

This glass-lined steel elbow was exposed to 10% HF for 1 day.

Glass lining completely removed from fitting.

This porcelain elbow was dropped 6 feet onto concrete.

Damage complete.

This plastic-lined steel elbow was heated at 250°F. for 1 day.

Short exposure to heat produced breakdown of the lining.

This high-silicon iron elbow was subjected to thermal shock.

This plastic elbow discolored ethyl acetate.

This "KARBATE" impervious graphite elbow was:

1. Exposed to 30% HNO_3 for 2 weeks
2. Dropped 6 feet onto concrete
3. Subjected to thermal shock
4. Exposed to 10% HF for 1 day
5. Heated at 250°F. for 1 day . . . and
6. Did not discolor ethyl acetate

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MANY corrosion-resistant materials are suitable for specific operations, BUT can they handle UNFORESEEN changes in operating conditions? The six materials shown above were subjected to conditions outside their range of application. They failed. But "Karbate" impervious graphite took all these conditions, and will continue to take them, not for days or weeks, but for years.

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NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information about products described on these pages use the coupon below, circling the number shown for each item desired.

Tube Expansion Control

1 Airetool Manufacturing Company's tube expansion control, now as a compact mobile unit, provides a convenient way to handle Airetool tube expansion equipment. The complete unit consists of a welded steel frame truck on which the control system, extra motors, expanders, mandrels, cables and accessory tools are placed on shelves. In the illustration, the unit is shown with the No. 866 electric motor on the top shelf and the largest motor furnished, No. 939, on the middle shelf. Four different electric motors are available for use with the control. When rolling heat exchanger and condenser tubes, the control automatically stops expansion when the tube is properly rolled. Bulletin 47.

Molybdenum-Base Lubricants

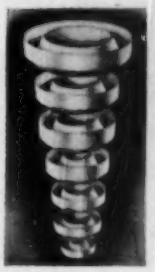
2 The Lubricants Division of The Lockrey Company has developed new forms of the "oil made of metal," which they introduced six months ago, "providing safe lubrication at high speeds, pressures and temperatures." The four new forms of the molybdenum-base lubricant—Liquid-Moly, NV Regular and Grease, Liquid-Moly NV Thread Compound and Moly-Wax-Stix—are described in Bulletin No. 21-E. Liquid-Moly attaches itself by molecular attraction to metal bearing surfaces, forming a lubricating film that cannot be "squeezed out" by pressure and which can withstand temperature extremes. Liquid-Moly NV Regular and Grease incorporated in a liquid glycol derivative have a high viscosity index which will pour as low as —25° F.

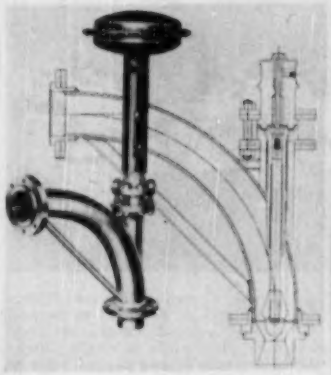
Silicone Rubber Rings

3 Frederick S. Bacon Laboratories' precision O-rings "provide hydraulic seals resistant to petroleum oils and most hydrocarbons, and are efficient under static conditions at either high or low temperatures." The O-Rings are molded from a mixture of silicone rubbers more resistant to deformation under compression than either natural or other synthetic rubbers and claimed to retain flexibility even at temperatures of —65° F and lower.

V-Ring Packing

3a "V-Ring" type packings of Teflon, made by Crane Packing Company, combine the chemically inert and frictionless properties of Teflon with resilience and toughness. A special cross-section design insures permanent sealing, even under varying pressures, at temperatures up to 450° F. The low friction characteristics and the ability of these V-Rings to withstand higher temperatures and corrosive chemicals increase the scope of hydraulic applications to the chemical field.





Long Sweep Angle Valve

4 Hammel-Dahl Company has announced the 7000S Series Flo-Tested Long Sweep Angle Valves designed to produce minimum turbulence in the flow through the valve and for use on slurry service where the solids

FOR ADDITIONAL INFORMATION on products and literature mentioned in this section circle item numbers, cut out and mail this coupon. Prompt action is suggested so that data will be readily available.

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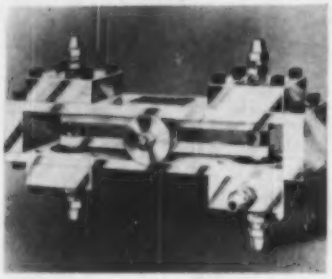
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207.)

in suspension tend to plug the conventional type control valve. The valve body is a long radius bend that can be fabricated from any type pipe which can be bent and welded. The high lift valve plug is streamlined for minimum flow resistance. A long plug guide assures guiding even where it is operating close to the seat. The one-piece seat, a section of a Venturi throat, is the retained type without threads.

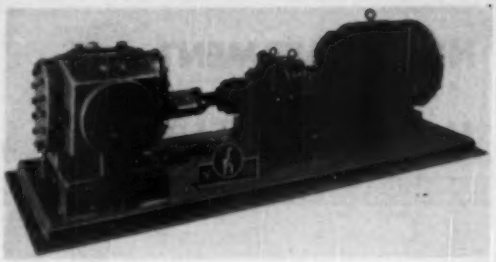
Control Mechanism



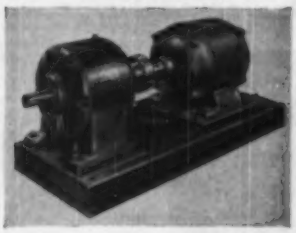
5 Hagan Corporation's new "Ratio Totalizer" is designed to receive several control signals or pressures and to produce a single output loading pressure in any desired ratio to the incoming loads. It is pneumatically operated and can accommodate as many as three input loading pressures plus three spring forces in a single unit. It was developed for use in computing circuits for such functions as additions, subtraction, multiplication, and division of control signals, and in control circuits for introducing proportional band action, rate action or automatic reset, either separately or in any desired combination.

Steam Jacketed Pump

6 A new Steam Jacketed Herringbone Gear Pump for handling viscous liquids such as hot road oils at high temperatures is being offered by Schutte and Koerting Company. To insure even thermal distribution, the steam jacket on these pumps cover the internal parts. The inlet, outlet and cover flanges are cast integral with the pump base, and rigid housing construction eliminates distortion due to pipe line strain or misalignment. Straight bore housing also prevents shaft deflection and bearing overhang. Shafts are of heavy duty alloy steel, finish ground. Pressure on the stuffing box is dissipated through a channel in the cover plates. Steam connections on the pump jackets are designed to permit a variety of piping arrangements.



Packaged Power Unit



7 Link-Belt Company has developed a new packaged power unit, Link-Belt motogear, consisting of an enclosed helical gear drive with separate standard motor, flexibly coupled and mounted on one welded steel base plate. Link-Belt Book No. 2247 describes this new unit. A movable plate between motor feet and welded base plate provides for convenient adjustment. Motogears, which are built in a variety of sizes, in double or triple reductions, and in a wide range of ratios and horsepowers, are also available as a separate self-contained unit without the motor.

Centrifugal Pump

8 De Laval Steam Turbine Company's Bulletin 1001, "Three Things You've Always Wanted in a Centrifugal Pump," describes the new Type GS pump which is designed to fit the idea of a service and exchange plan. All parts of the GS pump except the bare pump casing are contained in one replaceable rotor assembly. When maintenance is necessary, the old rotor assembly is removed and a new one is put in its place. The old one is then returned for credit on serviceable parts. The bulletin contains cross-section drawing, rating tables and dimension prints.

Foam for Fire-Fighting

9 Pyrene Manufacturing Company's brochure on air foam or mechanical foam for fire-fighting describes air foam, methods of application, high and low expansion types of foam compound, specifications and operating characteristics for five sizes of portable playpipes, mobile and stationary foam proportioning tanks and installations of the auto induction, pressure line inductor, "round-the-pump" proportioner, self-contained and motor fire apparatus types.

Anti-Corrosion Coatings

10 Anti-corrosion coatings for metal are described in "3M Adhesives, Sealers and Coatings," published by Minnesota Mining and Manufacturing Company. The coatings protect metal against acids, chemical fumes, solvents, crude petroleum impurities, high humidity and salt or fresh water, the booklet reports. The properties of over 110 industrial adhesive coatings and sealers are tabulated, and the availability of over 1000 formulas are cited.

Electronic Instruments

11 The Bristol Company's new line of strip-chart electronic instruments, Series 500 Strip-Chart Dynamaster electronic instruments, is a high-speed, self-balancing a.c. bridge designed for measurement of temperature, resistance, conductivity, strain, position, inductance, pressure,

Need More Data?

For additional information on New Equipment items or literature mentioned in this section, use the coupon on reverse side.

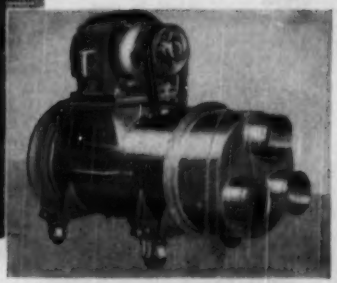
Prompt action is suggested so that data will be readily available.

This 22-Foot Hartzell Cooling Tower Fan Can Give You .... 1,250,000 C.F.M.

Shown on the Hartzell test stand is the new Hartzell 22-foot Cooling Tower Fan. Blades are of Hartzite plastic, which has proved itself to refiners so convincingly on Hartzell fans up to 20-foot diameter. It was run continuously at 125% of its rated speed on test; stresses developed were 55% greater than are encountered in service. It delivered 1,250,000 cfm at 180 HP.

This truly great new fan, on which we are now making deliveries in the sequence in which orders are received, will give you maximum cooling power per cubic foot of tower. Power cost per cubic foot of air moved is relatively low.

If you build or buy cooling towers using fans of 3' to 22' size, specify Hartzell. If you've had trouble with fans in existing towers, replace with Hartzell. Your troubles will end!



PORTABLE BLOWER CLEARS FUMES FROM TANKS

Shown above is a Hartzell Vaneaxial Blower "on casters." Easily lifted by two men; compact; powerful. Specially mounted by Hartzell to clear fumes from gasoline tank trucks before and during interior welding repairs. Each of three portholes, any or all of which can be used at one time, delivers approximately 500 cfm through a 15-foot long 5" hose. End assemblies easily reversible for exhausting or blowing. Other capacities can be produced.

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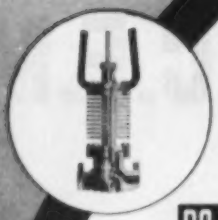
PROPELLER-TYPE FANS AND BLOWERS — ROOF VENTILATORS — UNIT HEATERS • ENGINEERING OFFICES IN PRINCIPAL CITIES

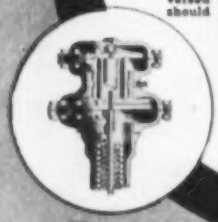
VERSATILE

Control flow, temperature, pressure or liquid level... handle air, gas, vapor, steam or liquids equally well with the BS&B-Climax type 86! Wide rangeability and constant proportional flow increase as valve opening increases with travel is a result of high-lift design and characterized inner valves. A full line of accessories permits scores of adaptations.

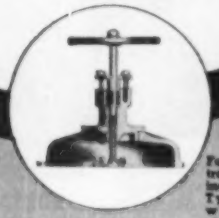


When flowing medium utilizes temperatures above 650° F., it is advisable to insert steel finned section for cooler operation.

Where needle valve or metering pins are used in valves that must be closed on failure of operating medium, Type 86 DRT with reversed top works should be used.



Where safety factors require that valve must not go out if diaphragm ruptured, employ Type 86 Duplex Diaphragm.



For manual control and for limiting valve travel, Type H Handwheels are installed on upper diaphragm casing.

BS&B

Climax DIAPHRAGM CONTROL VALVES

TYPE 86 is available in double port sizes ½ inch to 16 inches; single port, ½ inch to 4 inches. Pressure ranges are 125 to 5000 psi, within body limits. Parabolic, quick-opening, V-port, needle and metering pin inner valves are offered. Available with reverse top works, duplex diaphragm, finned cooling section, purged gland section, handwheels, bellows stem packing, steam-jacketed bodies and valve positioners.

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Climax Controls Division
Kansas City • Tulsa • Oklahoma City
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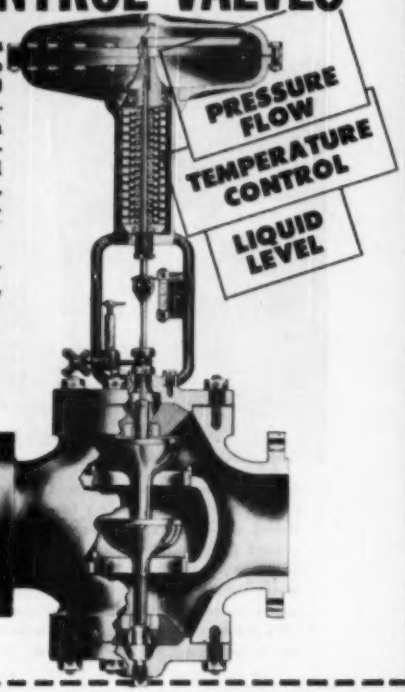

Quick, Clear Solution of Tough Problems ... in Strictest Confidence

Your BS&B-Climax Man is unique in that he has both long experience in process control and a complete, balanced line of quality controls. He appreciates your need for secrecy, and handles each assignment in closest confidence. If there is an answer, your BS&B-Climax Man can find it for you.

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Climax Controls Division
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☐ Send catalog and complete information about BS&B Climax Type 86 Diaphragm Control Valves. ☐ Have Sales Engineer call. No obligation to me, of course.

NAME_____

TITLE_____

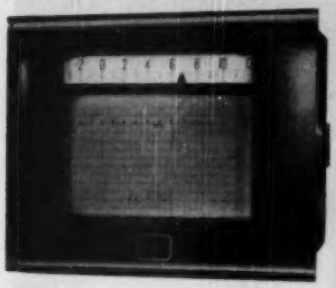
FIRM_____

STREET_____

CITY_____ STATE_____

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 267.)



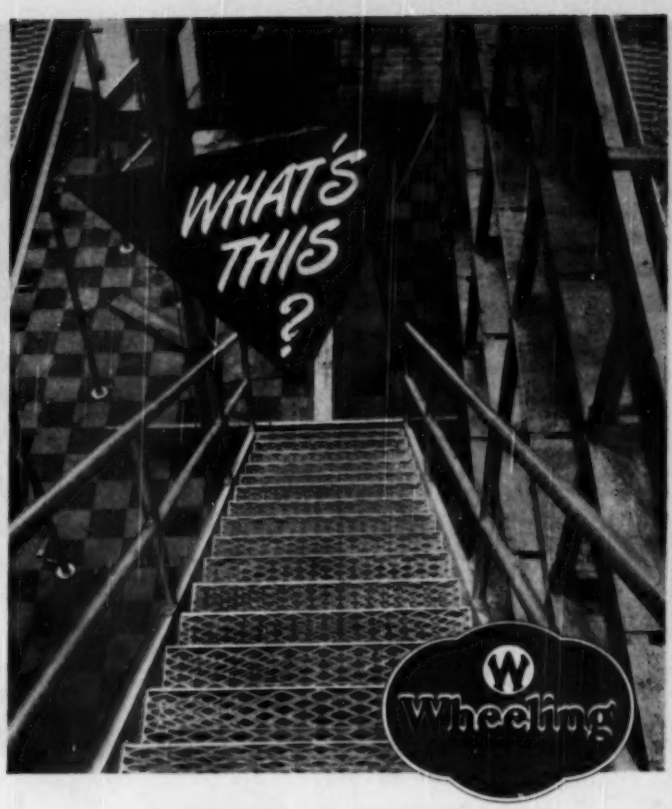
force, or any other variable which can be measured in terms of impedance. In addition, the instrument can be used for electric power totalization and as the receiver for Bistol's Metameter system of telemetering. In addition to the single record model instruments are available for as many as 16 different records on the same chart. Models are offered for full-scale pen travel in 7 records, 3 seconds and 2/3 seconds, with full range of standard chart speeds from 1 inch per hour to 120 inches per minute. Bulletin No. W1821.

Braided Packing

12 Palmetto Teflon Impregnated Packing with all the advantages of Teflon in braided packing form has been developed by Greene, Tweed & Company. Designated Palmetto 1330, it is prepared from chemically pure blue asbestos yarn impregnated with Teflon for resistance to acids, alkalis, corrosive chemicals and solvents, from —150° F. to 550° F. Because it may be cut or formed to any required packing size, Palmetto 1330 offers adaptability as a storeroom item to meet all size packing requirements. It is available in sizes from ⅛ inch square up.

Power Units for Stud Welding

13 Two special power units, specifically designed for use with Nelson stud welding equipment have been developed by Morton Gregory Corporation. One unit is a motor-operated generator set capable of welding studs up to and including ⅝ inch in diameter. The other, shown, is a specially designed battery-operated unit which can be used for installing studs up to ¼ inch in diameter with the Nelson automatic stud



Non-skid floor and stair treads made of

WHEELING EXPANDED METAL

"Material of a thousand uses"

Prevent slipping accidents with Wheeling ExM's underfoot security on floor and stairs, as in this laundry. Its criss-cross, non-slip design gives a sure grip to walkways, platforms, stairways. The strength of this modern construction material is another safety factor.

Made in many types, weights and mesh sizes . . . stronger than sheet metal of the same weight. Use ExM for property protection, tool room enclosures, partitions, tellers' cages—it does not cut off light and air.

Prevent accidents by using it for machine guards, radiator guards, window and skylight protection.

Excellent also for grilles, lockers, bins, parts trays and baskets. Easily formed to fit every need. *Write us for information.*

WHEELING CORRUGATING COMPANY

WHEELING, WEST VIRGINIA

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You can make important savings in fuel by taking advantage of the quick heating characteristics of J-M Insulating Fire Brick. These light-weight brick permit a quicker rise to proper operating temperature in the furnace because of their low heat storage capacity, and low thermal conductivity. Where furnaces are being intermittently operated these are two especially important characteristics.

These same insulating materials can also be obtained in large size units called Johns-Manville Insulating *Fireblok*. This product has many advantages over the smaller size fire brick for certain types of jobs . . . from both a construction and stability standpoint. The Fireblok units can be quickly applied because they are easy to cut and fit. Fireblok insulations provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

It will pay you to let a Johns-Manville insulation engineer explain the many ways in which you can save by using these insulations in your furnaces. Just write for further information to Johns-Manville, Box 290, New York 16, N. Y.

	JM-1620	JM-23	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	38	42	48	58	63-67
Transverse Strengths, psi	60	80	130	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage†, percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2,000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
3000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2200 F	2200 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

†24-hr. simulative service panel test for JM-3000; 24-hr. soaking period for other brick.

*Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.

Note: Above tests are in accordance with A.S.T.M. tentative standards.

Johns-Manville *first in* **INSULATIONS**

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207.)

welding gun. In stud welding performance, the Nelson power unit is equivalent to two conventional 400-ampere generators in parallel, yet it is comparable in size with a 200-ampere welding generator and weighs approximately 800 pounds. Either 220-volt or 440-volt, 60-cycle a.c. can be used with the new power unit. The battery unit, requiring only 110-volt A.C. convenience outlet for its operation, consists of twelve 6-volt, 150-ampere wet storage batteries mounted and covered with an easily-raised hood. An automatic battery charging device is mounted on top of the hood. The unit weighs approximately 1100 pounds.

Pump and Motor

14 A redesigned close-coupled "Electrifugal" pump and motor with internal and external design changes has been announced by Allis-Chalmers Manufacturing Company. The unit has new sealed motor bearings; a unit-cast frame which provides perfect and permanent alignment; double seal on front motor bearing which keeps liquid out of the bearing under normal operating conditions, and a large opening in the frame between the pump and motor to make packing maintenance quick and easy. Its all cast iron construction resists corrosive atmospheres. Bulletin 52B6140B.

Product Information Catalog

15 The new catalog of Alco Products Division of American Locomotive Company contains product information about heat exchangers, evaporators, feedwater heaters, pressure vessels and pipe. In addition to "how-it-works" information, design and selection data, and drawings of heat exchangers, evaporators and feedwater heaters, Alco has included sections on its new industrial exchanger and aircooler.

Penetrometer Timer

16 A recent development of Precision Scientific Company, the Penetrometer Timer, make penetration measurements "absolute" by eliminating the possibility of human error. Instead of simultaneously consulting a stopwatch and starting or stopping the Penetrometer, the operator simply flicks the timer control switch to "ON" position. The Pene-

with this New, Improved AIRETOOL Tube Rolling Control

You can save time and cut as many as 8 valuable hours from similar tube rolling jobs with this new AIRETOOL Control. Uncanny tube rolling accuracy is now assured, even with inexperienced operators.

MOBILE UNIT

BETTER these 8 important ways . . .

- The original control calibration is permanent . . . needs no adjustment.
- Relay operation is accurate and free from chatter.
- Employs or needs no delicate electronic tubes.
- No voltage regulator necessary for regular power sources.
- Minimum number of moving parts to wear out.
- Control consumes minimum current . . . delivers maximum power to motor.
- Every Control individually calibrated and shop tested before delivery.
- Designed for field and maintenance shop work as well as for new work. Available as a mobile unit.

BEST in Lab, Shop and Field . . .

Every test proves that the AIRETOOL control is the best obtainable at any price. Cash in on these benefits now. Write the AIRETOOL Manufacturing Co., 316 S. Center St., Springfield, Ohio.

There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

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FOR COMPLETE SERVICE AND DEPENDABILITY

You can't beat INTERNATIONAL REFINERY MIXING EQUIPMENT for the most rapid and economical blending of Gasoline, Gasoline Ethyl mixing, lubricating and fuel oil blending, as well as by-products liming, caustic and doctor treating . . . This up-to-date equipment is indispensible in cycling operations and pipe line work, and for uniformity in charging stock — mud mixing — a "natural" for research, laboratory and pilot plants.

Call on INTERNATIONAL'S vast experience for assistance in solving your Mixing and Blending problems. Our Engineering staff is at your service. Remember, INTERNATIONAL builds and guarantees the equipment you need for the best possible results at the lowest possible operating cost. Write for catalog and complete information on Top Entering, Side Entrance and Portable Mixers today.

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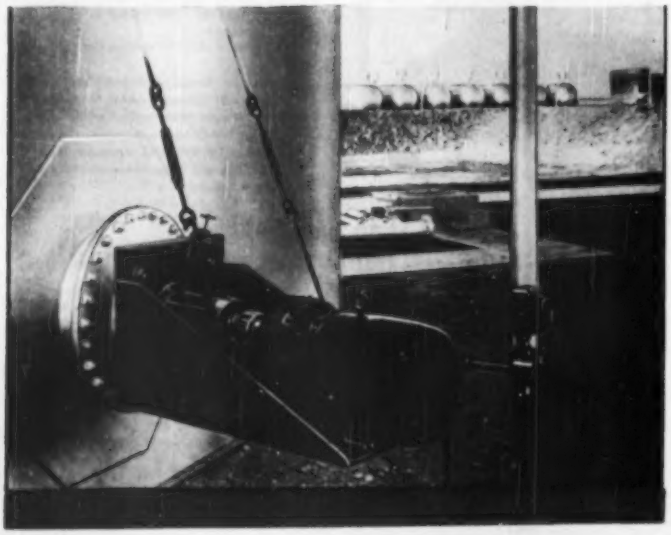

New Equipment

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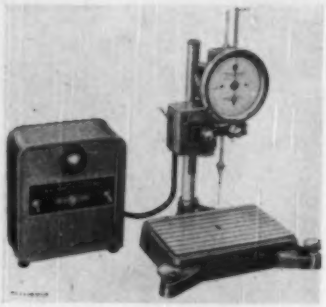


trometer needle is freed to allow penetration for exactly 5 seconds; the needle is then gripped and held immovable. Timing is made precise by a synchronous motor and cam actuating a microswitch to a solenoid which holds the needle shaft. The timer does not modify procedures specified in ASTM Series Nos. D-5, D-217, and others. Neither does it interfere with the use of any of the present needles or cones used in test procedures.

Packaged Regulator-Filter

17 A development of the Cono-flow Corporation, "Cono Airpak," is a combination of regulator, filter, and dripwell in a single compact unit. Constructed of brass and stainless steel, Airpak provides resistance to corrosive atmospheres frequently encountered in industrial processing plants and around seaboard areas. A side mounted drain cock permits horizontal as well as vertical mounting without sacrifice of filter area or dripwell volume. Filter medium is phenolic resin, impregnated cellulose capable of removing oil and water and particles down to 40 microns. Bulletin FH-15-3.

Process Equipment

18 A new catalog, "Buyer's Guide to Pfaudler Equipment and Services," published by The Pfaudler Company, describes the services, facilities and equipment of this manufacturer. The company has a consultation service on such projects as preliminary survey, the practicability of the process, the specification, manufacture, installation and trial run of the equipment. Bulletin No. 880.

Solid Front Gauge

19 A new solid front Acragage, announced by Clapp Instrument Company, incorporates a solid cast web backing up the dial with the entire back of the gauge case covered by a waterproof blow-out disc with bonded

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207.)

Buna N seal. This construction was designed for increased safety to operating personnel and for increased ease of maintenance. In the event of bourdon tube rupture, the blow-out disc relieves the pressure in the case. The solid front restrains any such pressures within the case preventing fracture of the glass lens. Removal of the waterproof disc exposes the entire mechanism for inspection, repair, or recalibration without removing the dial.

Process Equipment

20 Alco Products Division of American Locomotive Company has published a catalog of information about heat exchangers, evaporators, feedwater heaters, pressure vessels and pipe. It gives "how-it-works" information, and design and selection data with over 60 cutaway and cross-sectional drawings of heat exchangers, evaporators and feedwater heaters. It includes sections on the new industrial exchanger and the Alco Aircooler with a spread on production facilities.

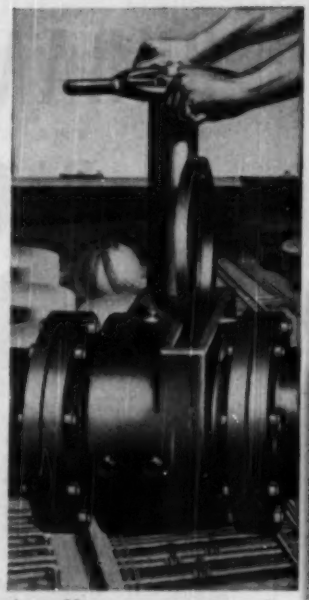
Sprocket Rim Folder

21 A new folder describing the advantages of the Babbitt adjustable sprocket rim with chain guide has been issued by Babbitt Steam Specialty Company. The sprocket rim is designed for operation of overhead or inaccessible valves, and hopper devices, from the floor. It comes in a range of 10 adjustable sizes to take care of all valve makes and types and fits valve-wheel diameters from 2 to 30 inches.

Melting Point Meter

22 Clarkstan Corporation has announced a melting point meter for the fast and accurate determination of melting points between 20° and 500° F. of waxes, resins, gums, fats, tars, plastics, low melting alloys, organic compounds and inorganic compounds. The Model 304 Clarkstan Melting Point Meter operates by placing a small quantity of the substance on a chromium plated platen or bar, which is electrically heated so that a temperature gradient obtains along its length. By observation, the demarcation between the molten and solid particles is determined. At this point the small thermocouple junc-

NOW BLIND RIGID LINES
in the COST-CUTTING
HAMER hand wheel operated way



When Hamer Line Blind Valves were introduced years ago, the old expensive and hazardous way of blinding pipe lines with a spectacle bolted between companion flanges became obsolete. The Hamer family of positive, one-man operated line blinding units has now grown until there is *a Hamer Line Blind Valve for every application*—EVEN FOR BLINDING RIGID LINES where no endwise movement is possible.

The new "RIGID" Line Blind Valve solves the problem of blinding inflexible lines in refineries, process plants, tankers and other ships...wherever rigid piping installations must be opened and closed. *It's speedy and cost-cutting*—one man can reverse the plate in one minute. It's *safe*—enclosed plate slot prevents spilling line fluid. *It's positive*—there's nothing like a solid plate for a permanent, leak-proof shut-off.

Positive shut-off without pipe line movement!

Actuated by the hand wheel, a smooth-turning ball bearing mounted ring gear moves the sliding internal sleeve in a straight line to clamp and release the plate, eliminating the need for spreading the line. "RIGID" Line Blind Valves conform to A. S. A. Standards for face-to-face dimensions of steel wedge gate valves. In planning new layouts, or modernizing existing installations, use a gate valve for blocking but specify Hamer "RIGID" Line Blind Valves at every point where quick, one-man operated, POSITIVE SHUT-OFF will be required.

LEFT—"RIGID" LINE BLIND VALVE

RIGHT—SPOOL-TYPE LINE BLIND VALVE

SPEED, ECONOMY, SAFETY IN BLINDING FLEXIBLE LINES!

There are Hamer Line Blind Valves for every blinding application. All models feature cost-cutting "one-man, one-minute" operation, positive shut-off, and long service life. Write for full information.

Illustrated below are: 1—Spool-Type, side hand wheel. 2—Spool-Type, upright hand wheel. 3—"Tee" and "Ell" Type. 4—Economy 3-Bolt Type.

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Non-Stick PLUG VALVES
OIL TOOL COMPANY
2919 GARDENIA AVENUE LONG BEACH 6 CALIFORNIA

Saves money...

Saves man-hours...

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Money Saving Sealing...

Do you know what your packing is really *costing* you in replacement sleeves—labor—production shut-downs? You save money when you specify Duralmetallic Packing because (1) it's "Engineered For The Job"—built for your specific conditions, (2) performs like a bearing—protects against wear on sleeves, shafts and stems, (3) actual service records prove Duralmetallic gives longer uninterrupted sealing—*definitely a money saver.*

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New Equipment

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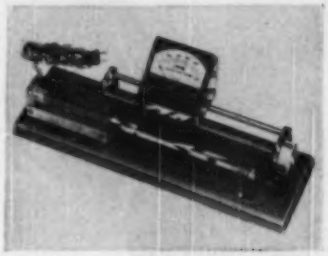


tion is placed. Within a few seconds the meter indicated the temperature of the point chosen. A screw feed allows the operator to follow the melting point as the bar temperature changes.

Centrifugal Pump Guide

23 Allis-Chalmers Manufacturing Company's Bulletin 52B6059G, "Handy Guide to Selection of Centrifugal Pumps" catalogs pumping units for every industry. Among those described are close-coupled, pedestal, double suction single stage, multi-stage, self-priming, fractional horsepower, coolant and circulating, fire, process, solids handling, marine, rubber-lined, paper pulp, sewage, axial and mixed flow pumps. Head capacity charts and tables are given along with data on sizes, capacities and construction features.

Electric Control System

24 A new control system by Leeds & Northrup Company, P.A.T. '50, introduces rate action into an electrically-actuated control. The significance of rate action is that it responds according to the speed with which the controlled variable changes, and thus improves process output by reducing the length of time that an upset can force the controlled process off its set point. P.A.T. '50 has proportional and reset control actions and is applicable to the regulation of temperature, pH, chemical concentration and gas analysis. The key element of the system is a new control unit, which electrically links a Micromax or Speedomax recording instrument and an L&N electric valve drive mechanism.

Floor Gratings

25 A Borden Metal Products Company catalog describes riveted and rectangular types of floor gratings and safety steps. These gratings and

STAINLESS STEEL CASTING

ELEVEN ACRES OF FOUNDRY FACILITIES

The above 24,000 pound 18% chromium and 8% nickel stainless steel hydraulic turbine runner casting was recently produced in the Newport News foundries for the Hoover Power Plant in Nevada.

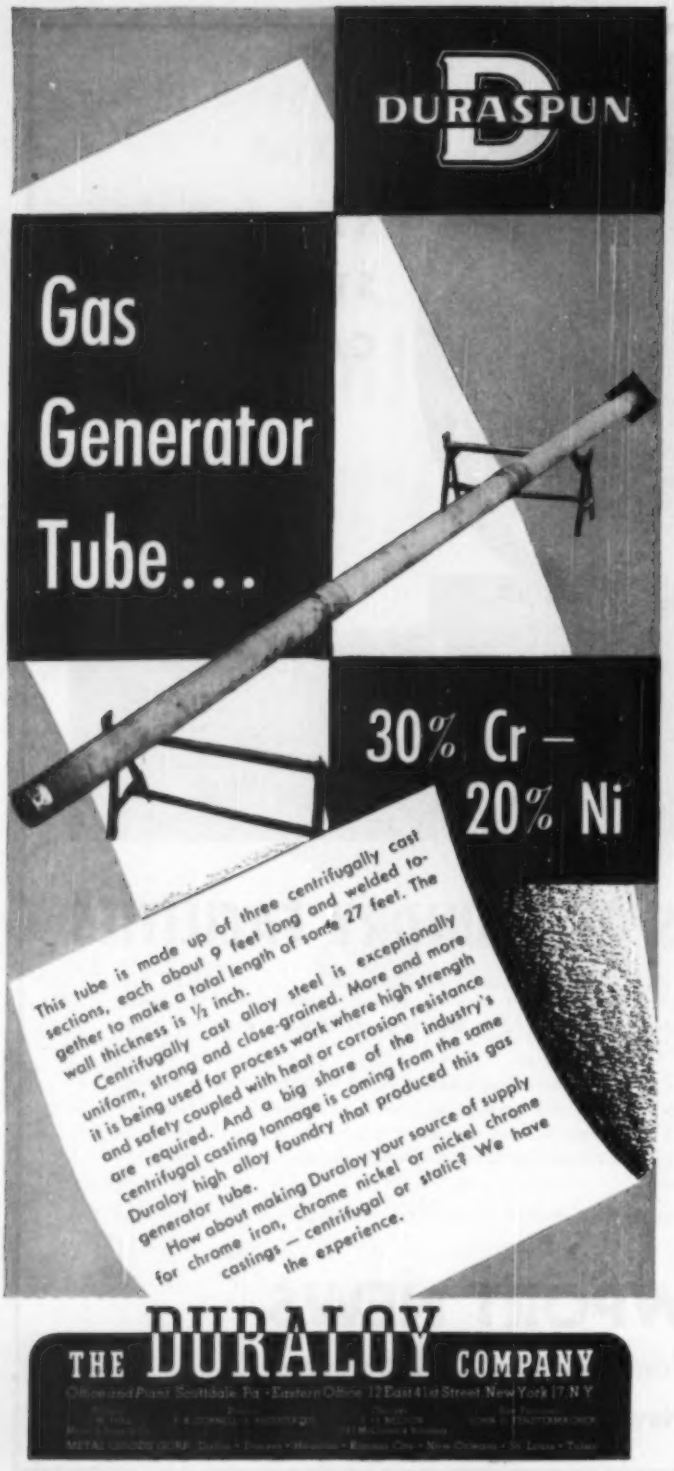
Eleven acres of foundry facilities including modern sand handling, mold making and melting equipment, are available for producing castings. In addition to metallurgical laboratory facilities for physical and chemical analysis, Newport News is equipped with Gamma-Ray, Radiograph and Magnaflux equipment to assure thorough inspection of foundry products.

Your inquiries for stainless steel, iron, steel and brass castings will receive prompt attention.

NEWPORT NEWS

Shipbuilding and Dry Dock Company

Newport News, Virginia

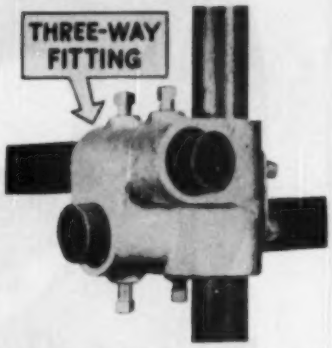

DURASPUN
Gas Generator Tube...
30% Cr – 20% Ni
This tube is made up of three centrifugally cast sections, each about 9 feet long and welded together to make a total length of some 27 feet. The wall thickness is ½ inch.
Centrifugally cast alloy steel is exceptionally uniform, strong and close-grained. More and more it is being used for process work where high strength and safety coupled with heat or corrosion resistance are required. And a big share of the industry's centrifugal casting tonnage is coming from the same Duraloy high alloy foundry that produced this gas generator tube.
How about making Duraloy your source of supply for chrome iron, chrome nickel or nickel chrome castings – centrifugal or static? We have the experience.
THE DURALOY COMPANY

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207.)

steps are used extensively for refinery walks, platforms and stairs. A chart of the safe loads for the different types is included.

All Metal Scaffolding



26 A new system of all-metal scaffolding made up of standard pipe and patented fittings has been announced by Amidon Sales Company. Quickly erected or dismantled, the scaffolding consists of standard steel pipe fastened together with fittings. A three-way fitting connects longitudinal, transverse and vertical pipes into a single corner joint and attaches one or two diagonal braces. A two-way fitting fastens two pipes at right-angles and permits building the scaffold to fit around circular structures and bends of any angle. A sleeve joins lengths of pipe and attaching casters.

Condensers and Centrifuge

27 Two new bulletins have been announced by Condenser Service and Engineering Company, Inc. Bulletin 102 describes the steam condensers made by the company and contains sections on installation, engineering, air removal equipment, maintenance, and steam condenser specialities. The other bulletin, published by Centrifuge Mechanical Equipment, Inc. division of the company, describes that division's continuous centrifuge and the continuous demulsifier.

Thermocouple Manual

28 A new edition of "Wheelco Data Book and Catalog" containing up to date prices, application recommendations and information concerning instrument sensing units and associated accessories, has been released by Wheelco Instruments Company. Among the special items included are resistance bulbs and wells, radiation detector, special thermocouples for plastic injection and extrusion machines and a new molten metal thermocouple for ferrous metals.

Interlock Receptacle

29 A new, safe interlock receptacle for hazardous locations has been developed by Panellit, Inc. A posi-

PLUGS ARE OUT WITH CHLORINATION

Costly plug cleaning, with its high labor bills and lengthy equipment down-time, goes out of the condenser and heat exchange picture the minute chlorination arrives.

This proven process for cutting the costly effects of back pressure and poor heat transfer characteristics caused by slime, really works, as one Southern Power Station found out when they began using the W&T De-sliming Process. In just six months after W&T Chlorinators were installed, cleaning and excess steam costs were reduced from $1450 per month to $250 per month and a later survey showed an overall saving in excess steam costs of $16000 in a year.

Such savings are indicative of how your condensers may be made to operate more economically and with far less outage when W&T Engineers install chlorination to fight your slime problems.

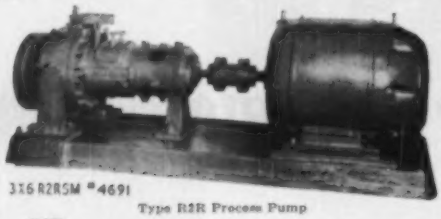
To learn how chlorination may be profitably applied to your heat exchange equipment and to take advantage of W&T's 35 years' experience, write today.

WALLACE & TIERNAN
PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities

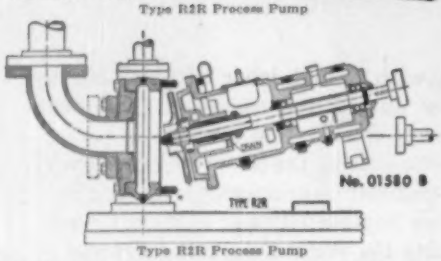
CD-31

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

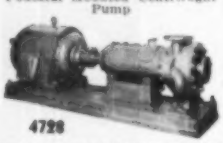
CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

Pedestal Mounted Centrifugal Pump

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: **NEW YORK, N. Y., HOUSTON, TEXAS**

Representatives in Principal Cities

New Equipment

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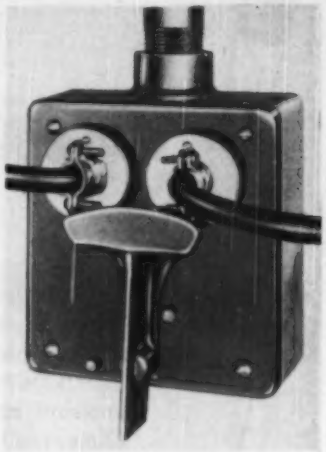


tive, safety cam lever which locks cord caps securely in the receptacle makes it impossible to remove the cord while current is on. A flip of the lever breaks the circuit, allowing plugs to be removed from the sockets. Standard flush type single or duplex receptacles, fitting any conventional cord cap, are used.

Flame Hardening Catalog

30 A new catalog, announced by Air Reduction Sales Company, a division of Air Reduction Company, Inc., contains descriptions and illustrations of the latest flame hardening equipment. It includes a section on "Tips for the Production Flame Hardening of Special Shapes" and discusses gas control equipment and pipeline systems.

Solvent Extraction Reprint

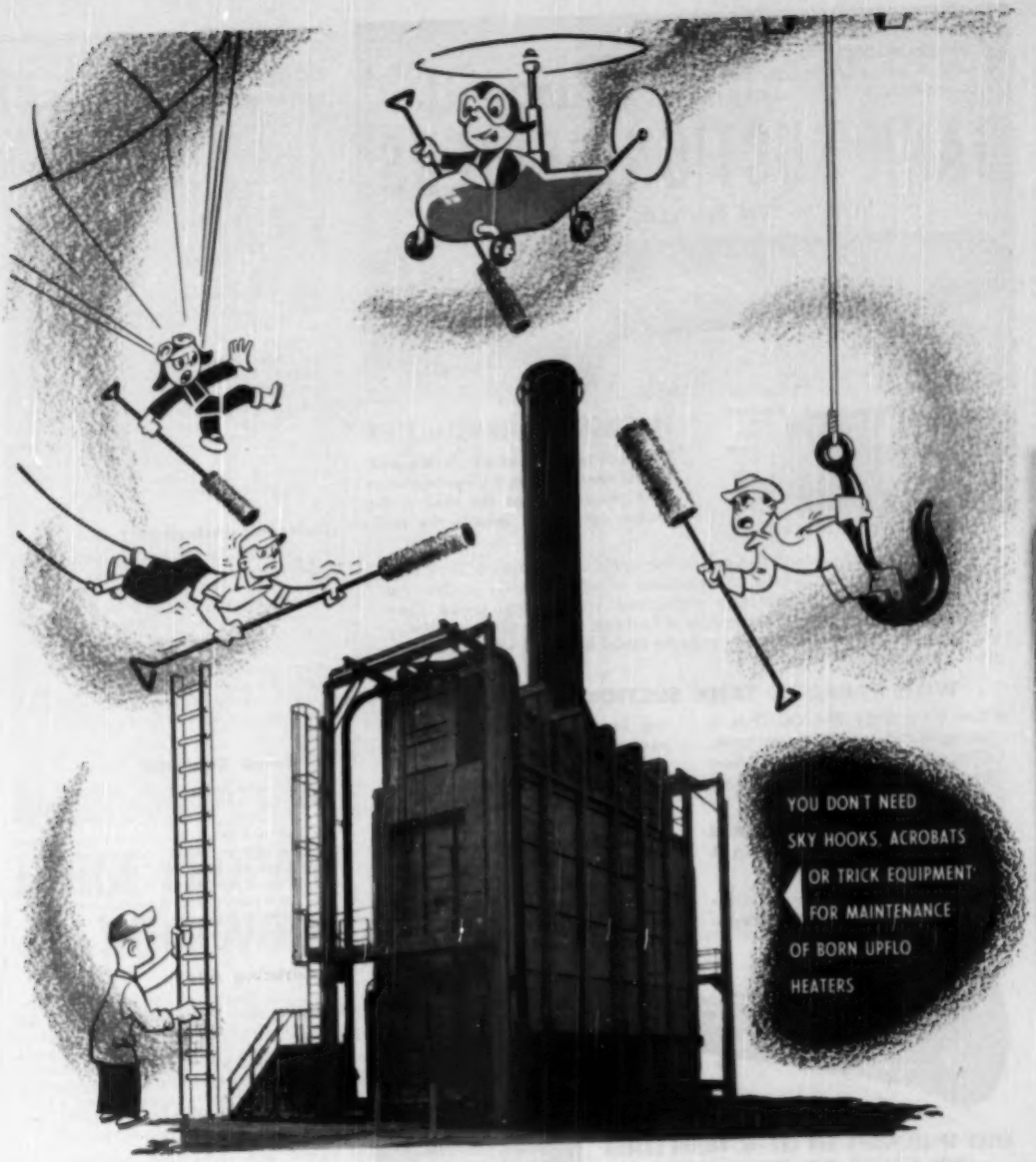
31 "Semi-commercial Multistage Extraction Column," a reprint on the performance characteristics of a 12-inch, 3-stage solvent extractor, has been published by Otto H. York Company, Inc. Data are presented on the effect of agitator speed, liquid throughput on the stage efficiency, and on many other phases that enter into the design and operation of a pilot or plant scale solvent extractor.

Double-Hung Arch

32 Refractory Hung Arch Bulletin Number 950, published by George P. Reintjes Company, describes how the arch hangs and moves like a pendulum. The bulletin explains the installation and the positive locking arrangement between the lower and the upper tiles, preventing disengagement in service. Rugged load tests given the double hung arch are described.

Teflon-Fabricated Gaskets

33 A new line of gaskets fabricated from Teflon has been developed by Chicago Gasket Company. Identified by the trade name "Korda," the new gaskets are expected to be of interest to product design engineers and



BORN Engineering Company

ENGINEERS and CONTRACTORS

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Canadian Associates, BRANDON, MANITOBA, Canadian Brown Steel Tank Co., Ltd.

HAVING TROUBLE PUMPING HEAVY OILS?
CONCERNED ABOUT LOSSES RESULTING FROM VOLUME SHRINKAGE AT LOW OIL DELIVERY TEMPERATURES? ...THEN INSTALL

Paracoil

TANK SUCTION HEATERS

TO SOLVE YOUR PROBLEMS

TANK SUCTION HEATER INSTALLATION

The shell is open at the inside end. The oil moves across the heating tubes as it passes through the shell to the suction connection outside the tank.

In Bulk Oil Terminals and Refineries the world over Paracoil Tank Suction Oil Heaters are licking the problem of economically preheating heavy viscous oils to permit their withdrawal from storage tanks. They are also preheating the lighter grades of fuel oils to their proper delivery temperatures to avoid the costly volume losses incurred when such oils are sold at low temperatures.

WITH PARACOIL TANK SUCTION OIL HEATERS

- **You Heat Only The Oil That Is Being Withdrawn From The Tank.** (Thus radiation losses resulting from heating entire tank contents are eliminated.)
- **Overall Steam Consumption And Heating Costs Are Held To A Minimum.**
- **Heater Tube Bundle Can Be Withdrawn For Inspection And Cleaning.** Breaking of oil suction line not necessary.
- **All Piping Connections And Gaskets Are Outside The Tank.**
- **U-Tube Design Permits Free Expansion And Contraction Of Tube Bundle.** Either high or low pressure steam can be used as the heating medium.

SPEED UP DELIVERIES AND CUT OIL VOLUME LOSSES WITH PARACOIL TANK SUCTION HEATERS

Prompt Shipments!
Our extensive stocks of tubing and pipe enable us to make quick deliveries to meet your immediate requirements.
Write for Descriptive Literature

In addition to the Paracoil Tank Suction Heaters, we also design and fabricate Line Type Discharge Heaters of any capacity. Illustrated is a Paracoil Straight Tube Type Fuel Oil Heater for bulk station service—capacity 2,000 gallons per minute, No. 6 oil, 100°F to 160°F, steam at 15 psig. Weight 12 tons.

DAVIS ENGINEERING CORPORATION

1060 East Grand Street, ELIZABETH 4, NEW JERSEY
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New Equipment

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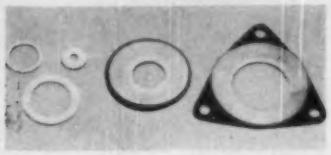


plant operating engineers in many industries including those pocessing chemicals. Teflon is a heavy-duty plastic excellent for its chemical and heat resistance. Among the Teflon-fabricated gaskets, both solid and jacketed forms, is the "Korda-Clad," a Teflon-jacketed gasket which offers a seamless, one-piece jacket of pure Teflon over a heavier wall of Teflon on the inside diameter of the gasket. Bulletins and technical service on the design, sizing and specifications of gaskets are offered.

Electronic Instruments

34 Bulletin W1821, describing The Bristol Company's new line of Series 500 Strip-chart dynamaster electronic instruments gives information concerning the new instruments for recording and indicating such variables as temperature, resistance, conductivity, strain, position, inductance, pressure and force. Photos of various models, reproductions of chart records and schematic drawings are also included.

Air Break Contactor

35 Allis-Chalmers has published two new bulletins. Bulletin 14B6410A describes "Type H Motor Starters" for 2300 to 5000-volt squirrel cage, wound rotor, synchronous and multi-speed motors. The other Bulletin 14B7303, describes in detail the "Air Break Contactor, Type 256," adaptable for applications requiring frequent starting, inching, reversing, plugging or dynamic braking.

Hardfacing Alloys

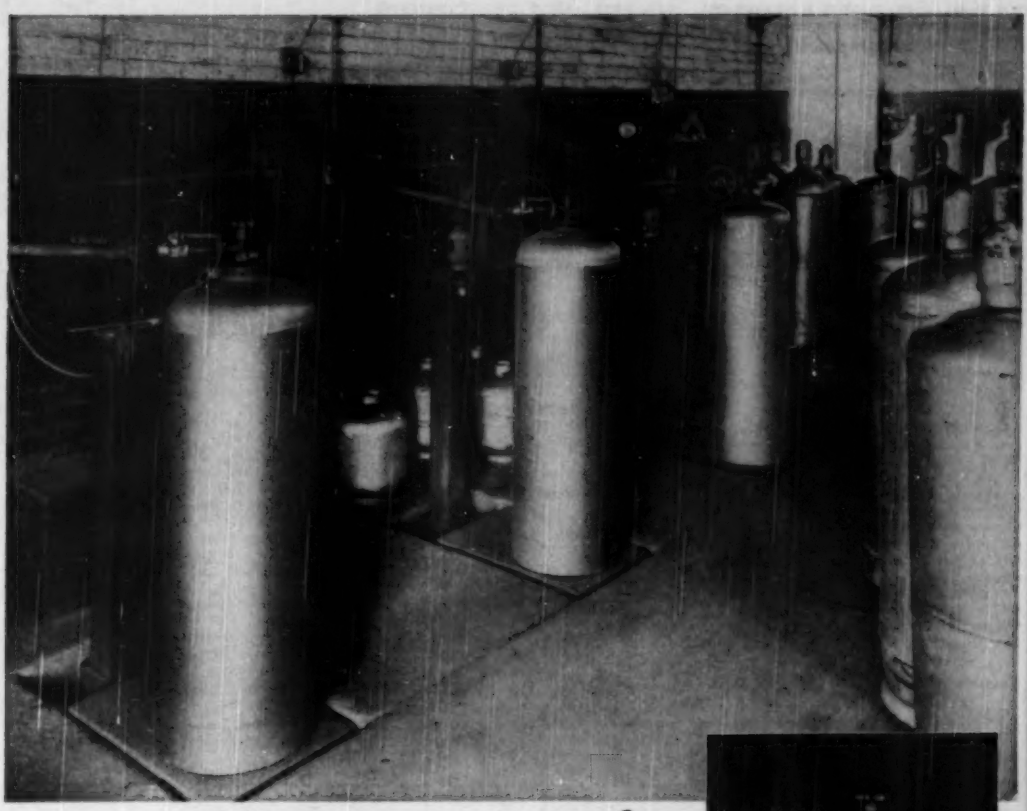
36 An illustrated catalog by Air Reduction Sales Company of Air Reduction Company, Inc., gives detailed information on the company's Airco line of hardfacing alloys. Description of product, typical uses, mechanical properties, chemical analyses and a brief outline of recommended procedures are included.

Steam Generators

37 Foster Wheeler Corporation's booklet, "Dual Circulation Steam Generators for Power and Process Steam of Super Purity," explains how the corporation's dual-circulation steam generator has been created to meet the increasing concern of steam purity to the designers and operators of industrial and central station steam generators.

Tube Rolling Control

38 A simplified tube rolling control, "John Crane Control," announced by Crane Packing Company is an electrically operated precision instrument designed for heavy duty service and is



½" Rockwood Ball Type Valve attached to tank helps speed the handling of "bottled gas". Note the construction and design of the valve —operator filling tanks can quickly open or close valve under full pressure with an easy quarter turn movement.

LARGE PROPANE PLANT *Cuts Cost* with ROCKWOOD Ball Type VALVES

The demand for liquefied petroleum gas has reached record highs in this large propane plant. Rockwood Ball Type Valves have increased the production of "bottled gas" by *cutting down* time and labor of operators. Each valve is opened and closed every two minutes during the day and between 300 and 400 tanks are shipped out daily to suburban and rural householders.

Plant supervisor is highly pleased with performance and action of the Rockwood Ball Type Valves. He says there is no question that the full *round* flow, tight seal and quick opening and closing features of the valves have contributed to greater production at lower cost.

Available in bronze with screwed ends in all pipe sizes from ½" to 4" for 300 p.s.i. working pressure, the Rockwood Ball Type Valve is recommended for handling water, oil, gas, petroleums, food lines, carbon dioxide, nitrogen and other gases, paraffin and asphalt base petroleums, also alcohol, paper fluids, and many other types of liquids and gases.

For additional uses and information on the Rockwood Ball Type Valve, write today for bulletin V-4.

Distributors in all principal cities.

ROCKWOOD SPRINKLER CO

102 HARLOW STREET WORCESTER 5, MASS.

New Equipment

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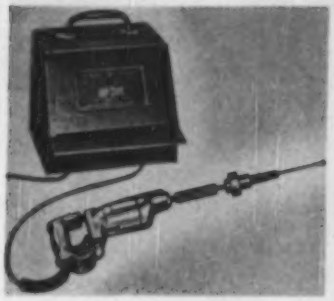


for rolling of both ferrous and non-ferrous tubing. The two electrical working parts are shock-proof mounted and enclosed in an aluminum cabinet to form a removeable, replaceable unit. Light weight and the absence of a voltage regulator make the entire unit mobile. The expanding gun is plugged into the control unit, and the dial setting for the desired size and gauge of tube is made. Pressure on the handle of the gun engages the control in the circuit. When the tube is rolled to the proper degree, the control cuts off the motor. Bulletin.

Combustible Gas Indicator

39 A combustible gas indicator designed for use on leaded gasoline has been produced by the Davis Instruments, a division of Davis Emergency Equipment Co., Inc. Known as the "Davis Vapotester Model M-1, Type L," it cannot be "poisoned" by tetra ethyl lead and is the only indicator thus for approved for use on "leaded stock" by Underwriters Laboratories and Factory Mutual Laboratories. It operates on the principle of the Wheatstone bridge. The indicator is suited for determining the gas-free condition of tanks and other enclosed vessels used in the oil industry. It registers the relatively light concentrations of vapors present after the tank has been steamed and ventilated.

Regulators Folder

40 A folder published by Spence Engineering Company, Inc., gives information on temperature regulators, pressure regulators, and desuperheaters. It contains a complete explanation of the principles of pilot operated regulating valves in addition to data and illustrations of 27 Spence pilots.

Corrosion-Resistant Valves

41 Alloy Steel Products Company's Bulletin 5, "Corrosion-Resistant Valves" describes the No. 62¼ needle valve and No. 66½ plug gate valve. Charts on the dimension of the various valve sizes are included.

Thermocouple Connectors

42 Section 23 of its catalog has been published by Thermo Electric Company, Inc. Entitled "Thermocouple Connectors and Panels," the section covers their quick coupling connectors and connector panels.

Concrete Saws

43 A new line of saws for cutting concrete has been announced by Clipper Manufacturing Company. Model C-75 with 7½-hp. engine and Model C-130 with a 13-hp. 2 cylinder engine, both gasoline-powered saws, are designed for the requirements of concrete contractors, utility companies, street repair departments, paving contractors and highway maintenance divisions. Models C-15 and C-20 with electric motors are produced specifically for plumbers, electrical contractors, and building maintenance departments. Model CHD makes it possible for owners of Clipper Model HD's to convert their masonry saws for concrete sawing. Features claimed for all models are floating three point suspension, which eliminates blade binding as saw is moved

MORE DATA—*and Quickly!*

For copies of manufacturers' literature or more data about the products described in Petroleum Refiner's NEW EQUIPMENT SECTION, use the coupon on page 207. Merely circle the number shown for each item desired, mail it in and the information will be ordered out for you without delay.

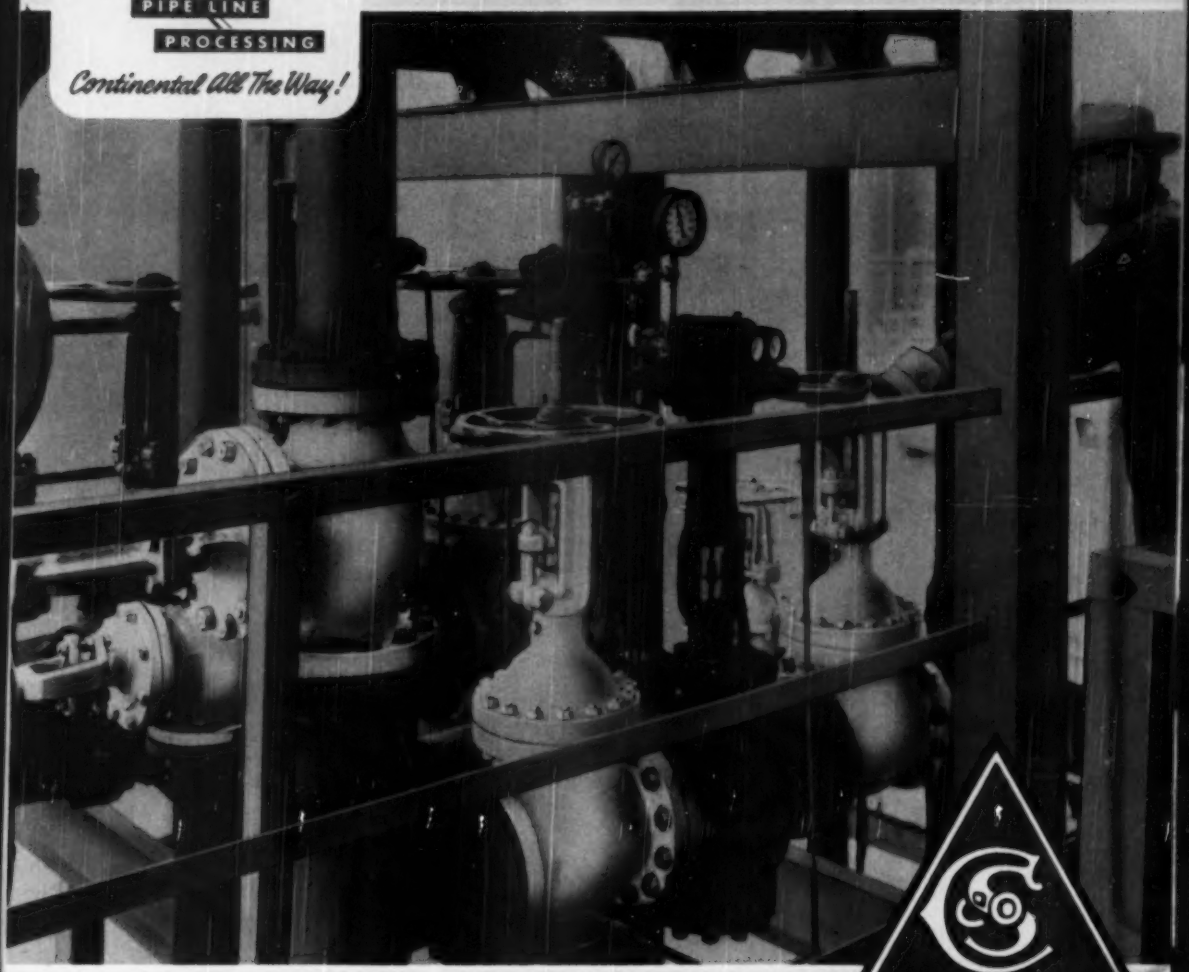
Get off the coupon TODAY

CONTINENTAL ALL THE WAY...

SERVING THE REFINING AND PETROCHEMICAL INDUSTRIES

DRILLING
PRODUCTION
PIPE LINE
PROCESSING

Continental All The Way!



- YOUNGSTOWN PIPE
- VALVES, ALL TYPES
- ALL NECESSARY CONTROL VALVES
- FORGED STEEL FLANGES
- SEAMLESS WELDING FITTINGS
- PRESSURE GAUGES
- COMPLETE LINE OF PAINTS

For over a third of a century Continental has served the Oil and Gas Industries through bringing them equipment of proved quality. Through the years, Continental's service and the caliber of the products offered, have set a pace in several phases of operation.

The great importance of the refining and petrochemical industries today is recognized by Continental. To that end the CSCO organization is keyed to furnish the entire processing field with equipment and supplies second to none in quality . . . and the dependable "Green Triangle" Service.

CONTINENTAL

SERVING THE OIL AND GAS INDUSTRIES

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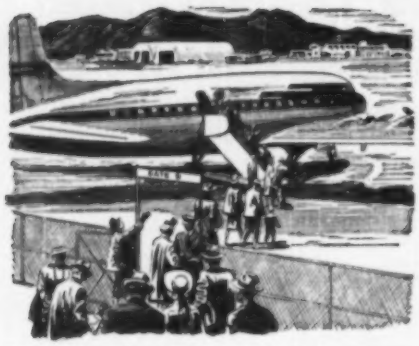
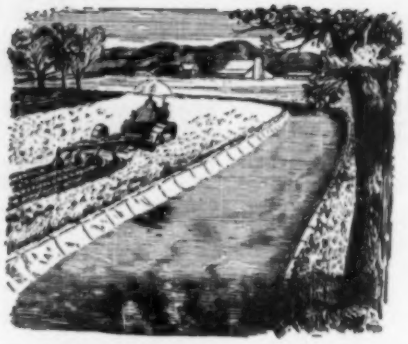


To help keep planes safe—a "Peak Temperature Indicator." This device, attached to motors, tells pilots instantly if any cylinder begins to heat up dangerously.



To help save the West's water—an inexpensive irrigation ditch lining. It's made by coating paper or aluminum foil with asphalt and keeps water from being lost into the ground.

To help protect diesel locomotives — a special detector and alarm which warns engineers if water leaks into the lubricating oil. Engines can be shut down quickly before expensive damage occurs.

Three new developments in Standard's laboratories

We picked these three developments to tell you about because they will probably never be manufactured by Standard of California.

Although we developed them, looking for ways to help some of our customers meet special problems, we expect to turn them over to other companies to produce. And this illustrates a point...

Everything we discover that can possibly benefit you is brought to you in some way ...even when the development leads us far outside our own field. And when we turn up a practical way to improve a petroleum product, we make prompt use of it and, in many cases, make it available to other companies under license.

Research at Standard is a vital, progressive force. It has called for an investment of more than $35,000,000 in the last ten years, but its results have been immeasurable...not only in terms of better products but in the creation of new jobs and greater opportunity for our own people and those in many other industries.

STANDARD OIL COMPANY OF CALIFORNIA

plans ahead to serve you better

New Equipment

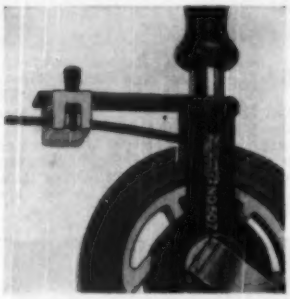
(For additional information or literature check item numbers on mailing coupon, page 307.)

over rough surface, positive screw feed, and streamlined design for ease of handling. Bulletin.

Air-Fed Hood

44 Chicago Eye Shield Company has announced a new No. 600 Air-Fed hood that is approved by the U. S. Bureau of Mines under "Class C" respirator for use in toxic dust and fumes. To provide comfort and freedom of movement, the hood is made of lightweight, flexible, rubberized fabric. It has clear plastic windows which allow wide angle vision, and the adjustable, plastic headband is mounted to the hood on a friction swivel to allow vision up or down as the user moves his head. Air fed into the hood is tubed to each side of the face, then diffused and filtered through cloth bags so that a supply of fresh air is maintained directly in the respiratory zone. A cotton bib acts as a baffle to keep out dust. The tough fabric of the hood protects against flying particles and is waterproof and acid-resistant. Operating pressure is 5 to 9 pounds.

Tape Wiper



45 A tape wiper developed by The L. S. Starrett Company can be attached to any Starrett frame-type tape to wipe the tape line clean of oil, mud or other dirt as it is reeled in. Designed for permanent attachment or use only on dirty jobs, the wiper is instantly mounted on the stud which secures the hand grip to the tape frame. Both sides of the tape ribbon are cleaned by pads which are held in uniform contact under spring pressure.

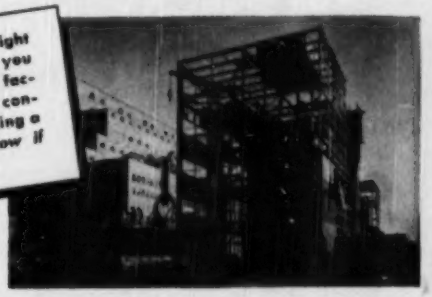
Threaded Plastic Pipe

46 Carlon Products Corporation has announced a new plastic pipe which is furnished in threaded sections together with molded plastic fittings which facilitate installation of standard or intricate systems for handling fluids or gases. The new pipe, Carlon "TL," is furnished in 20-foot lengths and incorporates standard International Pipe

BEFORE EXPANDING OR MODERNIZING YOUR PLANT

. . . ask these questions

To help you select the right contractor for the job you have in mind we list 5 factors which our clients consider vital before making a decision: Do you know if the contractor has—



1 ...ADEQUATE STAFF?

Chemical Plants Division has 300 engineers and experienced field supervisors. This organization is such that any project is handled with efficiency and dispatch—using the same care and cost-consciousness on small and large jobs, and employing the latest building methods and techniques.

2 ...RIGHT PROCEDURES?

Chemical Plants Division, through its own organization and that of many other Blaw-Knox Divisions has an international reputation for assuming all details—from site preparation foundations, structural steel erection, equipment design, equipment procurement and placing to final testing. This is proved by many completed projects.

3 ...EFFICIENT PLANNING?

Every contract undertaken by Chemical Plants Division is planned to the nth degree, so that scheduled dates can be met or anticipated, and construction progress in the most orderly and economical manner—often before all engineering is completed.

4 ...facilities for a COMPLETE JOB?

Chemical Plants Division is equipped to handle any project in its entirety under a single responsibility. It has the necessary specialists and complete facilities required for all phases of construction work from initial plans to plant operation.

5 ...the necessary BACKGROUND?

The financial standing of Chemical Plants Division is unquestioned. It stands solidly behind any work it undertakes.

• • •

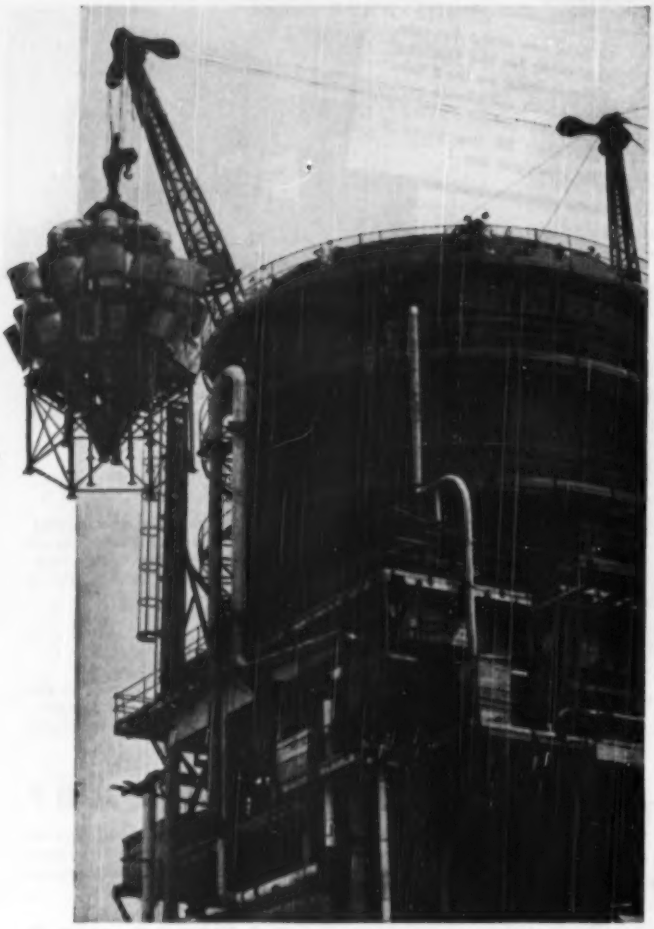
Regardless of the size or nature of your project, we of Chemical Plants Division are at your service, and welcome the application of the above "test" to our facilities, methods and personnel.

CHEMICAL PLANTS DIVISION

BLAW-KNOX CONSTRUCTION COMPANY

321 PENN AVE., PITTSBURGH 22, PA.

BUELL 'GOES TO THE TOP'
in catalyst recovery



In fluid or thermofor catalytic cracking Buell recovery systems have demonstrated continuous high-efficiency performance in all the major refineries. Design information is available on the latest multi-stage collectors. Buell Engineering Company, 70 Pine Street, Suite 5070, New York 5, N. Y.

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DUST COLLECTION

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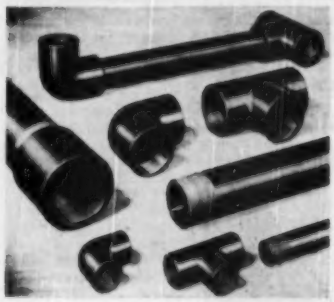
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207.)



Threads. It can be threaded and cut in the conventional manner and because of the inherent pliability of the plastic form which this new pipe is extruded, fit-up is rapid. Furnished in standard pipe diameters from ¼ to 2 inches, this new pipe for fluids and gases of all types is lightweight (approximately one-nineth the weight of steel). It is immune to rot, rust and electrolytic corrosion.

Seal for Liquid Petroleum

47 I. H. Grancell's new compound known as "Bestolife Lead Seal No. 960" for liquid petroleum, is packed in one pound containers and is used as a joint compound in sealing, fitting and mating of engaged pipe threads. It relieves friction, seizure and galling of mated surfaces, facilitates assembly of parts and prevents freezing of joints.

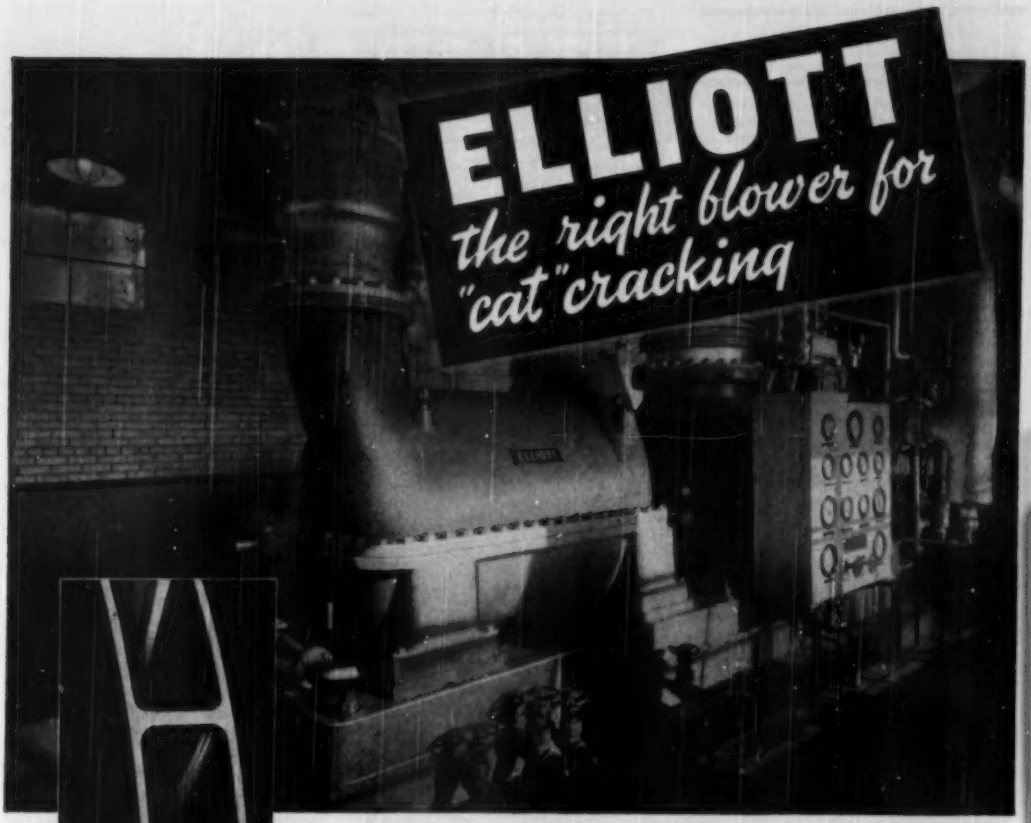
Hard Catalysts

48 Filtrol Corporation has developed a very hard type regular Filtrol TCC catalyst and a very hard SR (sulfur resistant) pelleted catalyst. These catalysts are suited for Houdriflow and Socony airlift units. Filtrol is proceeding with a $1 million construction program which will permit manufacture of these catalysts in large quantities by late Spring of 1951.

Screwdriver

49 The impakdriver, a new hand tool introduced by H. K. Porter, Inc., translates the impact from a hammer's blow into torque to tighten or loosen screws, bolts or nuts. Because of its principle, this dew device permits working in hard-to-get-at places. The

ELLIOTT
the right blower for "cat" cracking



WELDED IMPELLERS are one of the many reasons why Elliott blowers are getting ever-increasing acceptance for process work. Note the smooth contours, heavy blades, and generally rugged construction (as compared to conventional riveted impellers). Impellers are completely homogenous units, can be made of any weldable material having reasonable mechanical strength.

THIS ELLIOTT TURBINE-DRIVEN AIR BLOWER serves the new fluid "cat" cracker which recently went into service at the Big Spring, Texas, refinery of Cosden Petroleum Corporation. It provides the air for conveying and reactivating the catalyst. Installed at an elevation of 2600 feet above sea level (13.3 psia barometer), this blower is rated at 15,500 inlet cfm and discharges at a pressure of 25 psig. It is direct-connected to an Elliott 1575-hp condensing steam turbine operating at 5900 rpm.

Continuity of operation is an essential of "cat" crackers and other process requirements—an emergency shutdown may result in serious damage to equipment and prolonged loss of production. Elliott units have been designed with this requirement in mind and operating records prove conclusively that they have the rugged dependability necessary to meet the most exacting requirements. Contact your nearest Elliott representative for details.

P-1090

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DISTRICT OFFICES IN PRINCIPAL CITIES

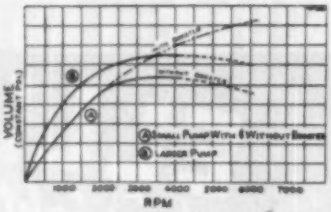
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207.)

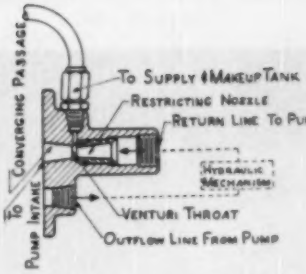
impakdriver is sold by itself or in sets with different combinations of bits and sockets for various sizes and types of screws, bolts and nuts.

Input Pump Booster

50 A solution to the problem of pressure loss at high speeds in geared, rotary vane and centrifugal pumps in the form of an input booster, without any moving parts, has been announced by F. W. Davis, consulting engineer of Waltham, Mass. Basically, the Davis Booster is said to greatly increase the range of speed at which pumps can operate at or near peak efficiency. This means that in some cases smaller pumps, operating at higher top speeds can be used rather than large pumps. In other cases, the efficient speed range of a given pump can be extended to permit effective operation at higher driven speeds. The operation of the Davis Booster is dependent upon the difference in pressure between the static head and velocity head in a venturi device. The booster mechanism may be added as an accessory or built into the pump.

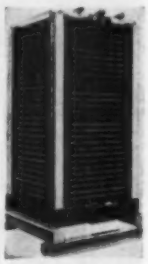


Davis Venturi Booster, right. Results are charted above.

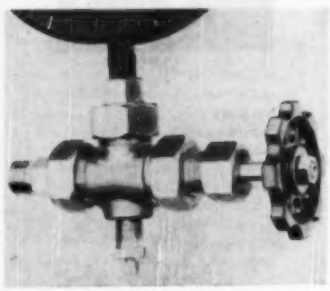


Cooling Towers

51 A new small capacity cooling tower featuring several advances in design has been manufactured by the Binks Manufacturing Company. It is described in Bulletin No. 44. Known as Binks Type "H," the atmospheric spray cooling tower is for use with small "packaged water-cooled air conditioning and refrigeration condensing units, and related applications. It is produced in ten frame sizes with refrigeration loads from 3 to 35 tons. As a new feature, the pan is made with external bolting flanges for convenient anchoring of the tower. Slip-fit louvers slide into place through machine-slotted corner posts of new design which guarantees spacing and angle. The float box, an integral part of the basin, is mounted externally.



Valves



52 Valves for instrument piping and general use which reduce threaded connections from 10 to 3 are available in a complete new line by Jerguson Gage & Valve Company. These valves, which combine unions, nipples, reducers, elbows, tees, valve, and drain valve into one unit, are offered in nine styles which include valves with or without union outlet as well as offset and jacketed valves. They are described in a new

How to Select a Cooling Water Service

First, look for a service based on sound engineering practice—one that is experienced in the solution of individual cooling water problems.

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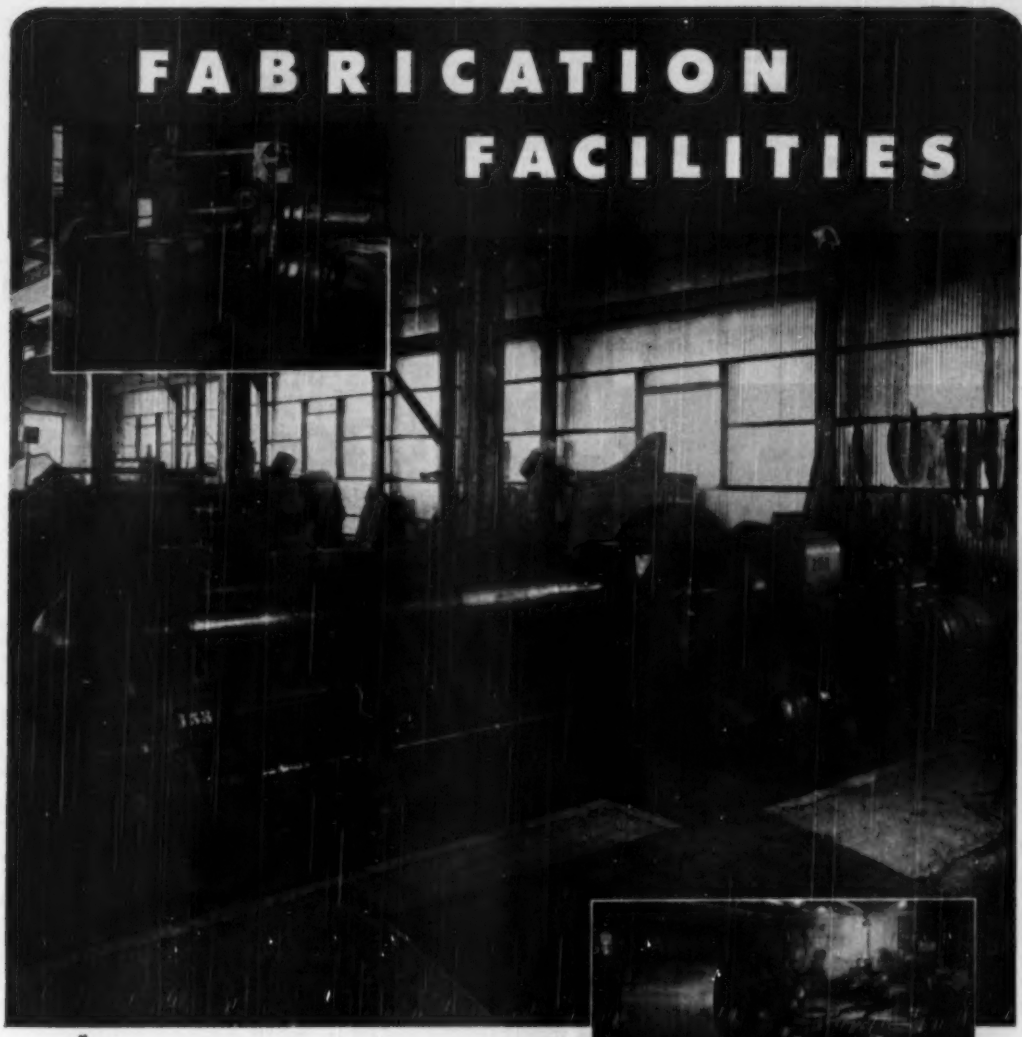

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New Equipment

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bulletin by the company. The valve shown is the Jerguson #64-GA Valve.

Porous Media

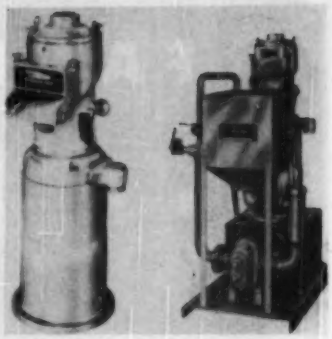
53 The Carborundum Company's new 56-page engineering bulletin, "Porous Media for Filtration and Diffusion," covers filtration and diffusion applications for ceramically bonded media. Numerous charts, tables, and illustrations supplement the technical information that deals with such uses as design, installation, operation, and specifications.

Sheet Material

54 "Build and Insulate with One Material," new illustrated folder by Johns-Manville, describes Marinite, the company's sheet material composed of asbestos fibers, diatomaceous silica and an inorganic binder. The folder tells of the use of Marinite for breechings, for construction of ovens and driers, and for fireproofing structural steel. A table gives Marinite's structural and insulating properties.

Grease-Processing Mills

55 Three new Speedline mills designed for processing greases and lubricants and a new deaerator unit for eliminating entrained air have been developed by Morehouse Industries of Los Angeles. The mills have set high production records in the processing of a wide variety of greases, including metallic-soap base and other new solid additive types. The new mills are Model MG designed for laboratory testing and control and custom runs, which weigh only 145 pounds, Model B-1405 (left above) with capacities as high as 8000 pounds per hour, and Model B-1405 with (right above) or without deaerator unit.

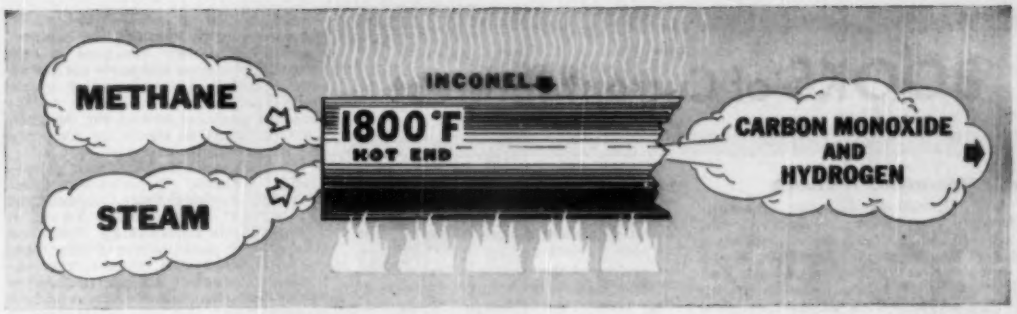


Diaphragm Control Valves

56 A Kieley & Mueller bulletin describes the K&M Series 1200 and 1400 diaphragm control valves with a motor that embodies "open yoke" features, found formerly only in cast iron construction, with the strength and resistance to shock found only in steel. The boltless casing assembly is constructed with an exclusive clamping ring which permits ready inspection and reassembly. Valve bodies are made with flow passages having a minimum average area of 140 percent of comparable size pipe area, and inner valve open free areas averages 80 percent of pipe area.

Extension Cord Reel

57 Industrial Products Company has developed a new heavy duty cord reel which has the approval of the Underwriters' Laboratories. It is non-kinking and non-fraying with a free moving swivel mounting. It has retracting speed and locks or releases at any cord length. Sealed-in lubricant requires no attention. Furnished with either 25 or 45 feet of rubber covered cord, it is available with various types of regular and vapor-proof hand lamps at the cord end, and it may be used with connector plug or without any wiring device if desired.



Hydrocarbon Synthesis—FROM METHANE AND STEAM

WILL INCONEL BE THE ANSWER TO THE HIGH TEMPERATURE PROBLEM?

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Inconel* is rightly regarded as one of the outstanding metals for resistance to high temperatures.

Now the questions are being asked: *Is Inconel the answer to the hot-end of hydrocarbon synthesis? Will Inconel have a service life measured in years rather than hours?*

Already On Trial

Nobody can say—but at least one manufacturer is using Inconel tubing for experiments in fuel synthesis from methane and steam. In this particular case, the components enter the synthesizer hot-end at a temperature close to 1800° F., passing through an Inconel tube that is heated on the outside by the combustion of methane. Inside surfaces of the tube operate continuously under carburizing conditions; the outside is exposed to severe oxidizing conditions.

Inconel was chosen because of its proved hot-strength and resistance to creep and carburization.

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Inconel has been used successfully by heat treaters in both strongly oxidizing and reducing conditions... at temperatures up to 2000°F. Inconel fixtures serving over two years are still in excellent operating condition.

REMEMBER *Inconel when you're looking for materials to resist carburization and oxidation at high temperatures in hydrocarbon synthesis. Turn some of your problems over to our Technical Service. These men know what has been done (and what is being done) to provide durable metals for your kind of work.*

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BOOKS of Current Interest

Unit Operations Textbook

Unit Operations, George Granger Brown, Alan Shivers Foust, Donald LaVerne Katz, Richard Schneidewind, Robert Roy White, William Platt Wood, George Martin Brown, Lloyd Earl Brownell, Joseph J. Martin, George Brymer Williams, Julius Thomas Banchero, and Jesse Louis York. John Wiley & Sons, Inc., New York. $7.50.

This 592-page textbook was written by members of the faculty of the University of Michigan and a member of Northwestern University's faculty in an attempt to present a comprehensive treatment of modern process operations.

Because of the variety of technical industries and the widening fields open to the engineer, the unit operation approach to the study of industrial processing was chosen by the authors. By this method, whereby the different operations common to many industrial processes are classified according to function, the engineer may recognize these functions in new industrial processes and apply his knowledge and skill in corresponding operations. The study is of interest to the operating engineer and to the designer, since all industrial plants are composed of a series of unit operations.

The book is divided into four parts—"Solids," "Fluids," "Separation by Mass Transfer; The Ideal Stage Concept," and "Energy and Mass Transfer Rates." It discusses unit operations that treat solids, those that involve fluids, those involving transfer of material from one phase to another by the method of equilibrium stages or contacts, and heat transfer which leads to the concept of rate of mass transfer as applied in crystallization, drying, absorption, distillation and more complicated operations.

Modern practices and equipment as well as mathematical interpretations are emphasized, and the sequence of operations is discussed according to increasing difficulty.

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API Publishes Oil Facts

Facts About Oil, Department of Information, American Petroleum Institute, 50 West 50th Street, New York 20. Free.

A compact collection of facts and figures on the domestic oil industry, this 32-page booklet is intended for use as reference and background by those who need a handy guide to up-to-date information. It is based on the latest available information from recognized government and industry sources.

The facts and figures are departmentalized under these headings: oil, its origin and progress; exploration, drilling; production; reserves; transportation; refining; supply and demand factors; marketing; uses of oil; cost factors; and oil and national security.

Graphs, charts and other drawings supplement the printed matter. A centerspread illustration makes a graphic presentation of supply and demand factors, prewar and today.

Pipe Line Mileage

Crude Oil and Refined Products Pipe Line Mileage in the United States, January 1, 1950. Information Circular 7585, by A. T. Coumbe and I. F. Avery, Bureau of Mines Petroleum and Natural Gas Branch, Publication Distribution Section, 4800 Forbes Street, Pittsburgh 13. Free.

Tables included in a new Bureau of Mines report break down pipe line mileage by states, by diameter of pipe, and by products handled, with data presented separately for trunk lines and gathering lines. The report shows that crude oil and petroleum products pipe lines were increased 25,463 miles to a total length of 152,814 miles between May 1, 1941, date of the last previous survey, and January 1, 1950, date of the new survey.

Chemical Process Forecasting

Sales and Business Forecasting in Chemical Process Industries, Robert S. Aries and William Copulsky, Chemonomics, Inc., 400 Madison Avenue, New York. $5.

What forecasting is, its methods, advantages, specific applications in chemical process industries and the way in which chemical process companies forecast are discussed in this 135-page book

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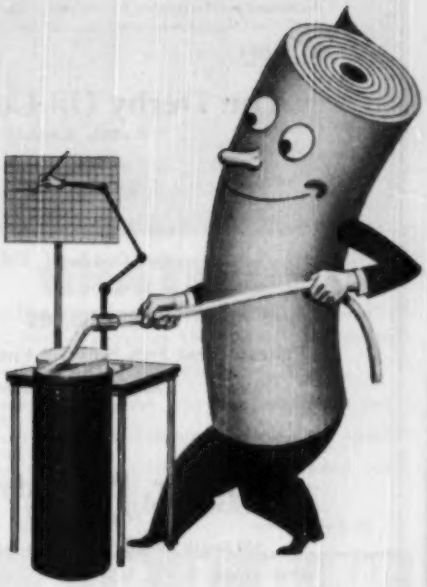

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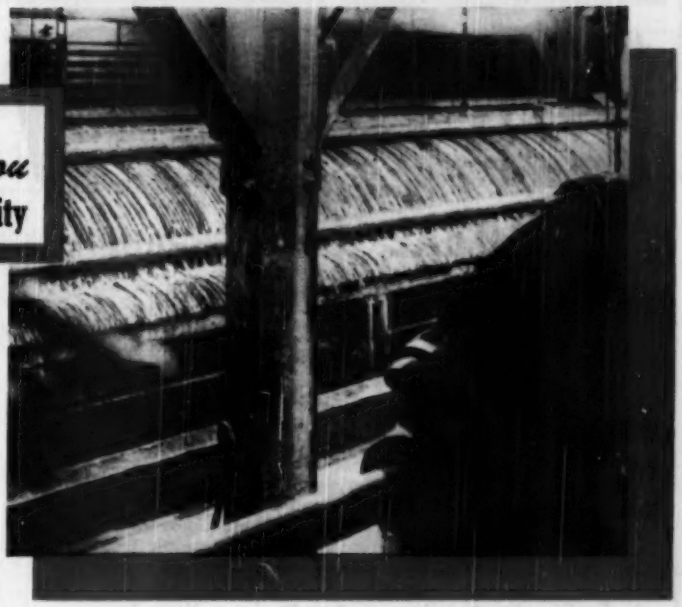

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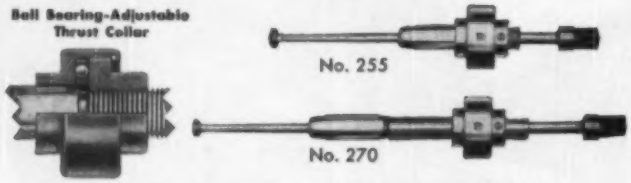

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BOOKS

by Robert S. Aries, adjunct professor of chemical engineering at Polytechnic Institute, Brooklyn, and William Copulsky, chemical economist with R. S. Aries & Associates, consulting engineers and economists, New York.

Among the methods of forecasting described are those of the Departments of Agriculture, Army and Commerce, the Bureau of Mines, Tariff Commission, British Chemical Manufacturers' Association, Pulp and Paper Association, Textile Economics Bureau, Vitrified China Association, R. S. Aries & Associates, Econometric Institute, Foundation for Study of Cycles, Industrial Commodity Corporation, Dunn & Bradstreet, McGraw-Hill, ECA, and the United Nations.

Hydrocarbon Physical Chemistry

Physical Chemistry of Hydrocarbons, Volume 1, Adalbert Farkas, Academic Press, Inc., 125 East 23rd Street, New York. $8.50.

Written primarily for the chemist, engineer or physicist engaged in hydrocarbon technology or research, this, the first of two volumes, summarizes the physico-chemical basis of techniques and methods recently adopted by the hydrocarbons industry. It has as its aim help for the research worker in exploiting these procedures more extensively and more intensively.

Though the data has previously appeared in various forms of publication, the two volumes will contain a record of all information available in the science of hydrocarbons.

The contents of Volume 1 include "The Chemical Bond in Hydrocarbon Molecules" by G. W. Wheland, "The Molecular Structure of Hydrocarbons as Determined by Spectroscopy and Electron and X-Ray Diffraction" by M. H. Jellinek, "Mass Spectroscopy in Hydrocarbon Analysis" by J. J. Mitchell, "Optical Properties of Hydrocarbons; Infrared Absorption, Spectroscopy" and "Optical Methods of Hydrocarbon Analysis" by Norman D. Coggeshall, "Electric Properties of Hydrocarbons" by Andrew Gemant, "Solvent Extraction of Hydrocarbons" by Alfred W. Francis, "Solid-Liquid Equilibria of Hydrocarbons" by M. R. Cines, and "Chemical Thermodynamic Equilibria Among Hydrocarbons" by Frederick D. Rossini.

Petroleum Chemicals Industry

The Petroleum Chemicals Industry, Frank Goldstein, John Wiley & Sons, Inc., New York. $8.50.

This 424-page book surveys the field of organic chemistry in which oil is the most economic starting material. It covers a wide range of subjects dealing with the manufacture of synthetic organic chemicals from petroleum, particularly the manufacture of hydrocarbon gases.

His British background enables Dr. Goldstein to view the scope of this essentially American industry more impartially than an American might have done. He reviews its problems and possibilities thoroughly from the vantage point of an outside observer. In his description of what has been accomplished, he places emphasis on the period since 1940.

Chapters deal with source materials . . . the hydrocarbons present in crude

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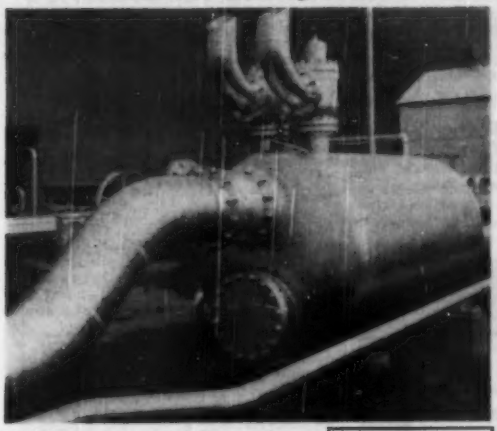

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With one set of dies the fully adjustable 41-E Geared Threader threads 2½, 3, 3½ and 4-inch pipe, no dies to become lost or mislaid. Cuts oversize, undersize, standard taper pipe or straight conduit threads without changing dies.

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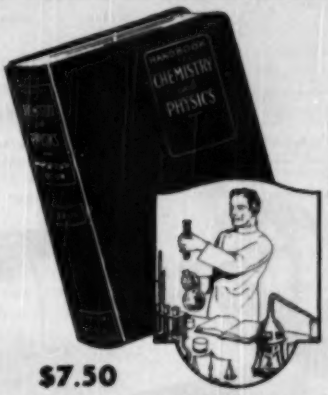

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Books

petroleum or produced as by-products in the refining operations of the petroleum industry itself; the chemistry of paraffins; the manufacture of olefins and the chemical developments based on them; the manufacture of other classes of hydrocarbons—diolefins, naphthenes, aromatics, and acetylene; the manufacture and reactions of the principal classes of petroleum chemicals; and a summary of chemical by-products, usually non-hydrocarbon, arising from refinery operations.

Research Without Investment

Research Facilities Without Capital Investment, Foster D. Snell, Inc., 29 West 15th St., New York 11. Free.

The function of the chemical consultant in today's industry is discussed in this new 20-page brochure.

In addition to illustrations of facilities and equipment, the booklet outlines briefly the relation of equipment and personnel of the consultant and the result to be expected on various types of problems. This is followed by answers to: "Why use a consultant?" "What is research?" and "What can research buy?"

Natural Gas Properties

Tentative Standard Procedure for the Determination of Carbon Dioxide and Oxygen in Natural Gases, Bulletin TS-501 of Technical Committee of California Natural Gasoline Association, 510 West 6th Street, Los Angeles 14. $2 for members, $2.50 for non-members.

This bulletin, which was recently completed by the technical committee of California Natural Gasoline Association, is intended as an operating manual for the analyst in the laboratory and in the field. Included in this bulletin are the test procedures for laboratory and field determinations of carbon dioxide and oxygen in natural gases.

Soda Ash Manual

Soda Ash, Pittsburgh Plate Glass Company, Columbia Chemical Division, Fifth Avenue at Bellefield, Pittsburgh 13. Free if requested on company letterhead.

A detailed history of an important basic chemical, soda ash, is presented in a comprehensive 64-page illustrated manual, "Soda Ash," compiled by the technical staffs of the Pittsburgh Plate Glass Company Columbia Chemical Division and Southern Alkali Corporation.

Chapters in the book treat of soda ash production and uses, methods of manufacture, forms and grades, and unloading and handling. A technical data section with tables and charts outlines the properties of soda ash and various methods of analysis.

Is there a better bulk plant pump?
There is! THE NEW GILBARCO ROTO-PRIME!
POSITIVE SELF-PRIMING on suction lifts. Self evacuating against discharge pressure.
No reservoirs or relief valves.
No gear reductions; operates at standard motor speed.
Designed for outdoor service without secondary covering.
Mechanical seal for trouble-free operation and freedom from leakage.
Minimum maintenance — motor oil lubricated.
Ball bearing equipped for long wear and efficient operation.
Capacity 50 to 450 g.p.m.
Gilbarco Roto-Prime Pumps are complete units — with base, electric motor, coupling, built-in check valve and mechanical seal.
Gilbarco
ROTO-PRIME
Self-Priming Centrifugal Pumps
GILBERT & BARKER MFG. CO.
WEST SPRINGFIELD, MASS.
TORONTO, CANADA

Three-Fold Theme Planned For ASME Annual Meeting

Three major props of a technological civilization—the development of power, the design of machines, and the management of men—will be examined at the 1950 Annual Meeting of The American Society of Mechanical Engineers, to be held November 27-December 1 at the Hotel Statler, New York. More than 7500 engineers are expected to attend.

In a world divided by conflicting ideologies, the ASME has chosen "The Engineer and His Civic Responsibility" as the theme of the meeting. Keynote speaker A. W. Robertson, chairman of the board of Westinghouse Electric Corporation, will sound the theme in his address at the president's luncheon on the opening day of the meeting.

More than 200 papers will be delivered during 83 sessions of the meeting. Fields to be covered include power, aviation, applied mechanics, fuels, gas turbines, heat transfer, hydraulics, industrial instruments and regulators, machine design, management, materials handling, metal engineering, oil and gas power, process industries and petroleum.

The National Power Show, now under the auspices of ASME, will be held in the Grand Central Palace, New York, November 27-December 2, concurrent with the ASME Annual Meeting.

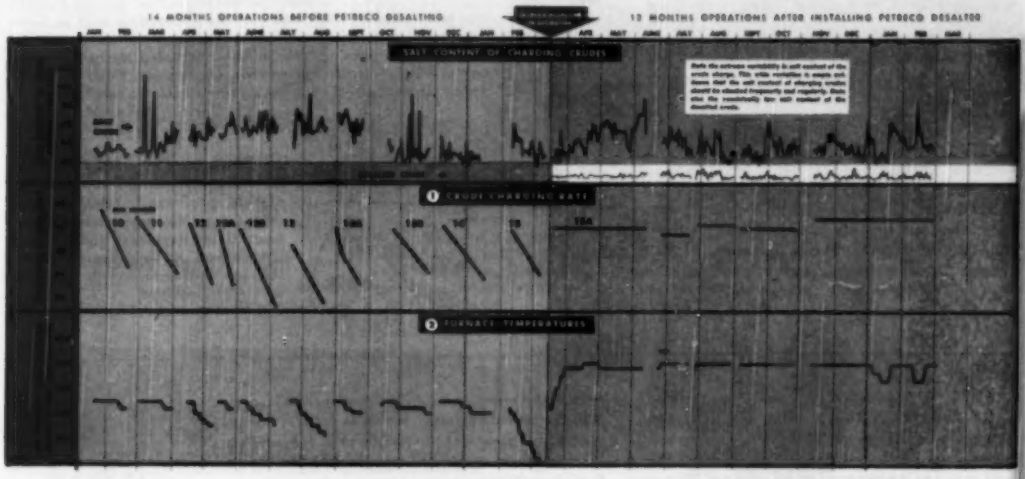
Economist Is Selected as IPAA President's Assistant

Minor S. Jameson, Jr., who has been economist for the Independent Petroleum Association of America since 1937, has been named assistant to the president of the association. J. E. Warren, IPAA president, said the new post was made necessary by increasing activity of the association and by the broader scope of independent oil industry problems.

A 1934 graduate of Massachusetts Institute of Technology, Jameson was in the Economics division of the Federal Trade Commission in Washington for three years after graduation. He then joined IPAA's Washington office

OVER TWO YEARS OF RECORDED REFINING OPERATIONS PROVIDE GRAPHIC PROOF OF BENEFITS FROM PETRECO DESALTING

For a 26 month period, 14 months *before* the Petreco Desalter was installed, and 12 months *after* the desalter was in operation, refinery personnel at a Texas refinery carefully observed and graphed the effects of salt on the operations of one unit. Particular attention was paid to the salt content of the charging crude and to the charging rates and furnace temperatures, both before and after installing the Petreco Desalter.


14 MONTHS OPERATIONS BEFORE PETRECO DESALTING
12 MONTHS OPERATIONS AFTER INSTALLING PETRECO DESALTER
SALT CONTENT OF CHARGING CRUDES
CRUDE CHARGING RATE
FURNACE TEMPERATURES

The top graph shows the wide variation in salt content before desalting with Petreco, and to what low values Petreco reduced the salt in the crude charge.

Graph No. 1 shows how the comparatively high salt content of the crude caused the daily charging rate to decline. The effect of Petreco Desalting is obvious in the right hand section.

Graph No. 2 illustrates how Petreco Desalting permitted the use of higher *sustained* furnace temperatures. Before desalting, even the lower temperatures employed dropped off rapidly.

Petreco desalting does not necessarily benefit every refiner in exactly the same way, since refineries differ widely in charging procedures, flow schemes, and so on. However, regardless of the physical characteristics of the crude charged, the flow scheme of the refinery, or the type of refining procedures used, with every installation, Petreco Desalting has shown a rapid pay-out in improved operations, increased capacities and substantial maintenance economies.

Profit by the experience of the many refiners who rely on Petreco for the more economical operations assured by efficient salt removal. For further information, write or call

PETROLEUM RECTIFYING COMPANY

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ONLY PETRECO OFFERS COMPLETE DESALTING SERVICE PERSONNEL AND FACILITIES

PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

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AIRCO

YOUR SUPPLY DEPOT
for
OXYACETYLENE FLAME AND ELECTRIC ARC WELDING AND CUTTING EQUIPMENT AND SUPPLIES

AIRCO GASES AND CARBIDE

Airco Oxygen is produced and tested under the most rigid scientific procedures, and is guaranteed to be 99.5% pure in the cylinder. High purity assures maximum speed and economy in cutting, and greater efficiency in welding.

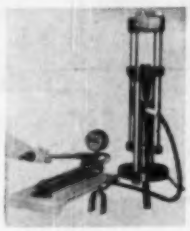
Airco Acetylene has been proved by use and test to be the most economical fuel gas for pipe welding and other flame welding operations.

Other Airco gases such as Nitrogen, Hydrogen, Carbon Dioxide and the rare gases Argon, Neon, Helium, Xenon, and Krypton (and mixtures thereof) for commercial and laboratory use are available through a nationwide distribution system. Nitrogen and Oxygen may be also obtained as a liquid and Carbon Dioxide in solid form.

National Carbide (in the red drum) assures the user of a high acetylene yield – better than 4.5 cu. ft. per lb. It is made from the finest available coke and limestone by the most modern manufacturing methods. It is evenly sized and dust-free. Available in five sizes in 25-lb. and 100-lb. drums, 2-lb. and 10-lb. cans.

OXYACETYLENE APPARATUS AND SUPPLIES

Airco No. 846 Welding, Heating and Cutting Outfit. This is the outfit for heavy-duty as well as light and medium day-by-day production welding and occasional cutting. The five tip assemblies will weld metals from the lightest gauge to the heaviest section. Other special purpose tips make possible additional profitable operations such as flame hardening, flame cleaning, silver brazing and the heating of large sections prior to welding. Also included in the outfit are two dual-stage regulators, wrench, goggles, spark lighter, and a special cutting attachment for cutting metals up to 1" thickness.



Airco Tensile and Bend Testing Machine. This machine permits rapid testing of weld specimens in the shop, laboratory, or on field operations. Guided bend tests, transverse tension, and longitudinal all-weld metal tension tests are quickly made with this compact Airco machine.

AIRCO HARDFACING ALLOYS add 2 to 25 times LONGER SERVICE LIFE to worn and new parts Whatever your wear problem – heat, corrosion, impact or abrasion – Airco's New Hardfacing Alloys will give you the most effective solution. With one application of these wear-retarding materials, the service life of both worn and new parts is increased, in some cases, at least 25 times.

Airco Pipe Cutting and Beveling Machine. This portable flame cutting machine is the fastest, most economical means of preparing pipe for welding. It simultaneously cuts and bevels pipe to any angle. It is chain driven and turns around pipe or remains stationary as pipe is revolved. Airco also has available a full line of other portable and stationary shape and straight line oxyacetylene cutting machines.

ARC WELDING MACHINES, ELECTRODES AND ACCESSORIES

The Wilson "Yellow Jacket" is a ruggedly constructed, gasoline engine-driven generator that has proved ideal for field welding. Features include compactness, improved automatic idling device, close coupling of drive and generator. Made in 300 and 400 amp. sizes. Also available are 200 amp. Wasp and Hornet Specials with air-cooled engines.

The Wilson "Hornet," famous for its smooth, steady arc, easy regulation, and reliable service, is ideal for general purpose DC welding. Made in 200, 300, 400 amp. sizes.

The Wilson "Bumblebee" AC welders (indoor and "All-Weather" models) are supplied in 200, 300, 400 and 500 amp. sizes and other AC units in 750 and 1000 amp. sizes.

A complete line of shielded arc AC and DC electrodes. Airco No. 78E is ideal for DC all-position, general purpose welding where excellent physical qualities are needed. Airco No. 387 is recommended for single or multiple pass DC or AC welding on rusty work and where fit-up is poor. Airco No. 230 is a "top-notch" electrode for all-position AC welding.

Arc Welding accessories include helmets, holders, clamps, gloves, brushes, etc.

***For additional details on any of these products, please contact the nearest Air Reduction Magnolia office.**

AIRCO **AIR REDUCTION MAGNOLIA COMPANY**

A Division of Air Reduction Company, Incorporated

Beaumont • Corpus Christi • Dallas • El Paso • Fort Worth • Hobbs
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Southwestern Headquarters for Oxygen, Acetylene and Other Gases . . . Carbide . . . Gas Welding and Cutting Machines, Apparatus and Supplies . . . Arc Welders, Electrodes and Accessories

About EQUIPMENT and SERVICE Suppliers

UOP Public Relations Head Honored for Company Service

Harvey W. Blankenship, director of public relations of Universal Oil Products Company, was honored at a dinner given by David W. Harris, president of Universal in recognition of Blankenship's five years of service to the company.

Blankenship

Guests included advertising men, newspaper writers, industrial publishers, Chicago bankers and lawyers, and many members of the UOP organization. The principal speaker was Colonel Russell L. Putman, Chicago publisher. Brief talks were made by Harris and Dr. Gustav Egloff, Universal petroleum scientist.

Work Starts on Omaha Plant

Construction has been started on the new Quaker Oats Company Omaha Chemical plant. The plant is expected to be completed and in production of furfural, a chemical used in making nylon and other products, by the end of 1951.

Worthington Names Manager For Petro-Chemical Sales

John V. Jirasek has been appointed manager of sales activities in the petrochemical industries for Worthington Pump and Machinery Corporation. His headquarters will be at the company's executive offices in Harrison, N. J.

Jirasek received a chemical engineering degree from the University of Prague and did postgraduate work at the Sorbonne, Paris. He joined Worthington as special representative to the petroleum and chemical industries in 1940. Prior to his association with them, he was connected with The M. W. Kellogg Com-

NEW CALIFORNIA HEADQUARTERS—Petroleum Rectifying Company has consolidated its office, laboratory, service and manufacturing facilities at 1390 E. Burnett Street, Long Beach 6, Calif. A new office building, shown above, was constructed and recently occupied, and existing buildings modernized. The new Petreco unit is one of the many oil company headquarters located in the historic Signal Hill district.

Federated first for Lead Products

Asarco Sheet Lead... All commercial weights and sizes. Chemical...Tellurium Chemical...Antimonial.

Asarco Lead Pipe... All commercial sizes. Special sizes on request. Chemical...Tellurium Chemical...Antimonial.

Asarco Lead and Lead Lined Valves ... Split Type "Y" and "Angle", Standard "Y", Gate, Check, Hard Lead "Y", Plug and Cock.

Asarco Lead Fittings... Elbows, Crosses, Tees, "Y's", (with plain ends, with flanges on, or for flanging in the field). Chemical and Antimonial.

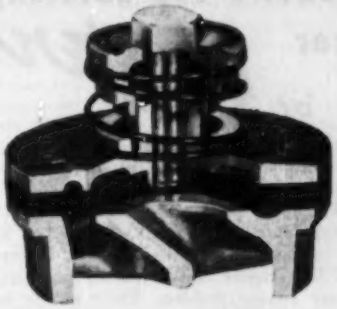
Asarco Lead Wool... 5/8" rope in 50 lb. waterproof bags.

Asarco Lead Specialties... Extrusions and Castings to specification.

See Federated also for Lead Lined Pipe Lead Lined Fittings, Lead Lined Flanges

Federated Metals Division
AMERICAN SMELTING AND REFINING COMPANY
120 BROADWAY, NEW YORK 5, N. Y.

SIMS INCLINED PORT ROTATING PUMP VALVES



GUARANTEED TO:

1. REDUCE Seat and Disc Wear.
2. INCREASE Pump Capacity.
3. REDUCE Maintenance Costs.
4. WORK Efficiently in Light or Heavy Liquids.

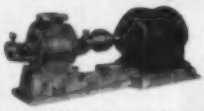
Sims Valves are available for all reciprocating pumps.

Write for Catalog V-111

SIMS PUMP VALVE CO., INC.
145 Hudson Street, New York 13, N. Y.
Houston Office: M & M Building, Houston, Texas

Better on "1001" Pumping Duties

Capacities to 150 G.P.M. Heads to 500 Ft.



WE STOCK APCOS IN STAINLESS STEEL

APCO Two-Stage Turbine Type Pump for High Pressure Service

Apco—the pump with but one moving part, the impeller — is famous for long-lived, efficient performance on small capacity, high head duties. Available in Single Stage, Two Stage and 4-Stage Tandem for high pressures — and Water Jacketed for high temperature and highly volatile liquids.

Write for Bulletins 111, 111-A, 111-WJ

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AURORA Always PUMPS

AURORA PUMP COMPANY

Versatile Top Entering Mixer by Eastern

Versatile! Series C Vertical Mixers do big mixing jobs quickly and thoroughly. Their power range is from ¼ to 15 H.P. at standard speeds of 1725, 1140, 420, and 280 R.P.M. Standard NEMA ball-bearing type motor is furnished. Stuffing box is separate component and can be specified in any alloy for low original cost. Write our engineers about your mixing problem. Their service is without obligation.

Send now for new Eastern Mixer Catalog No. 600

Write for new Eastern Mixer Catalog No. 600

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pany in the U. S. and with its European representative, the Compagnie Technique des Petroles in Paris, and the Sharples Corporation in Philadelphia.

Satterwhite Named President Of American Meter Division

American Meter Company has elected J. H. Satterwhite as president of Westcott & Greis, Inc., division of American Meter Company, with headquarters in Tulsa.

Satterwhite

Satterwhite, a graduate of Virginia Polytechnic Institute, became associated in 1917 with Henry Greis, at that time sole owner of Westcott & Greis, which had formed Westcott & Satterwhite for the sales distribution of Westcott gate valves. In 1920 the two organizations were combined, and on the death of Henry Westcott, Westcott & Greis was incorporated, becoming a division of the American Meter Company in 1933.

Nelson Stud Welding Appoints Five New Distributing Firms

Arrangements for additional distribution of Nelson stud welded fasteners through four national manufacturers and distributors of construction materials and one regional firm have been announced by Nelson Stud Welding Division of Morton Gregory Corporation.

United States Steel Supply Company will distribute Divweld studs directly to purchasers of corrugated steel and aluminum roofing and siding, while Southern States Iron & Roofing Company will handle the same products in 13 southern states.

Philip Carey Manufacturing Company, Cincinnati, and Asbestone Corporation of New Orleans will both handle Nelson stud welding fasteners through their established national sales channels. The Armstrong Cork Company, Lancaster, Pa., will handle Nelson stud welding insulation pins and speed clips.

Phillips Glass Blowing Lab Offers New Glassware Service

Phillips Petroleum Company's glass blowing laboratory in Bartlesville, Okla., is offering a service for fabrication, modification or repair of glassware items of unusual or intricate design. R. J. Brunfeldt is in charge of this specialized operation.

Such service has in the past been limited to Phillips' own requirements. Sales will be handled by W. C. Lacy, manager of the instrument sales section of Chemical Products division.

Air Reduction Company Names New Assistant Chief Engineer

Leigh W. Haefle has been appointed assistant chief engineer of the General Engineering department of Air Reduction Company, Inc. The company also announced the appointment of Dr. E. R. Blanchard as assistant manager of the Research division.

Haefle was graduated by Bucknell University in 1931 and joined Air Reduction in 1938. He was responsible for a part of the engineering work con-

99%

CATALYST RECOVERY?

Research Corp. Engineer: Yes sir. Actual operating experience with our Cottrell precipitators shows recoveries as high as 99.6% of fluid catalyst.

Refinery Executive: What about draft loss?

Research Corp. Engineer: It's extremely low —only a few tenths of an inch of water.

Refinery Executive: Do you actually guarantee performance?

Research Corp. Engineer: Absolutely. And you can depend on a Research Corporation guarantee because of Research Corporation's 38 years experience in electrical precipitation.

RC 130

RESEARCH CORPORATION

405 Lexington Avenue, New York 17, N. Y.
122 South Michigan Avenue, Chicago 3, Illinois

SEEING IS BELIEVING WITH *Rochester* STAINLESS STEEL DIAL THERMOMETERS

Extremely sensitive, accurate and durably made of high quality stainless steel, you can depend upon Rochester Dial Thermometers to indicate temperature changes quickly in all types of service. There is no squinting at hard-to-see mercury columns. Big, bold dials permit you to take readings at a glance. You see quickly . . . and can believe what you see!

The new precision bi-metallic element is extremely sensitive, quickly reflecting temperature changes. It is free from indicator vibration and extremes in temperature do not cause distortion. Rugged construction guarantees long life. All exposed parts are stainless steel.

Rochester Dial Thermometers are available in many types, stem lengths and scale ranges. For specifications and prices on these or any other combinations, mail form.

No. 1725—3" dial No. 1750—2" dial No. 1825—6" dial
Stem lengths 2½", 3½", 6", 9", 12", 15", 18", 24"
One piece Sockets—to fit all stem lengths

TEMPERATURE RANGES		
Fahrenheit	*Centigrade*	*Dual Scale*
—50 to 120°F. 50 to 350°F.	—70 to 160°C.	—90 to 130°F.
—70 to 150°F. 0 to 500°F.	—10 to 110°C.	—70 to 56°C.
0 to 200°F. 150 to 750°F.	0 to 150°C.	
0 to 300°F. *200 to 1000°F.	0 to 300°C.	
30 to 240°F.	100 to 400°C.	

*Not recommended for continuous operation above 800°F.

Rochester GUARANTEED ACCURACY

ROCHESTER MANUFACTURING CO., INC.
38 Rockwood St., Rochester 10, N. Y.

We require..... dial thermometers with temperature range of ..... to ....."; ....." dial; ....." stem.
Please quote.
Name ..... Title .....
Company .....
Address .....
City ..... State .....

nected with the expansion of Airco oxygen and acetylene producing facilities during World War II.

Dr. Blanchard received his Ph.D. from The Johns Hopkins University, where he was an associate professor from 1935 to 1943. He later worked on the Manhattan Project, and in 1946 joined Air Reduction as a physicist and technical consultant.

Shand & Jurs Office Moved

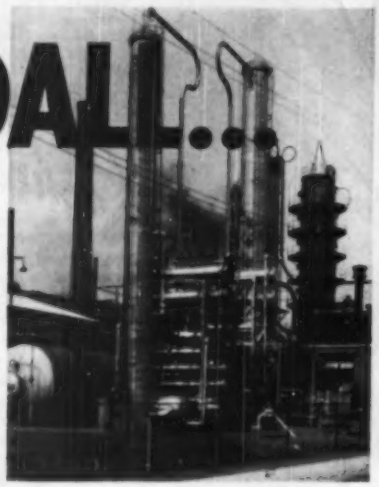
The Chicago quarters of Shand & Jurs Company, Berkeley, Calif., manufacturers of petroleum equipment, have been moved to 10409 South Western Avenue, Chicago 43. The new quarters have their own warehouse and storage facilities. Mail and stock shipments will be handled from this address.

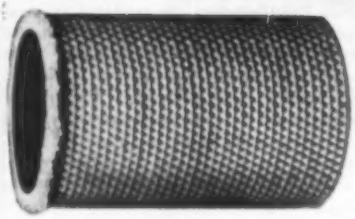
BUYS NEW PLANT—Water cooling equipment facilities will be provided in this new Binks Manufacturing Company Plant at 4915 Pacific Boulevard, Los Angeles. The plant will be under the direction of J. E. Roche, manager of the West Coast division, and will be the focal point for all branch office work involving the warehousing and selling of standard spray finishing and assembly of air compressors, as well as water coolers.

GOODALL...

The Name That Assures Lasting Reliability in

FIRE HOSE





COTTON RUBBER LINED, SINGLE OR DOUBLE JACKET

All Standard Sizes

Every detail of construction contributes to the strength, durability and safety for which this hose is famous . . . as perfect in quality as it is possible for men and machines to produce. Jacket of selected long fibre cotton duck withstands exceptionally hard wear and rough treatment, with effective resistance against snagging, puncturing, bursting. Rubber lining is tough, durable, carefully cured. Flexibility and relatively light weight assure easier handling and coiling.

NOTE: For fire smothering service, red covered "INFERNO" Steam Hose is recommended.

Contact Our Nearest Branch for Complete Information and Prices

GOODALL RUBBER COMPANY

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

Branches: Philadelphia · New York · Boston · Pittsburgh · Chicago · Detroit · St. Paul · Los Angeles
San Francisco · Seattle · Portland · Salt Lake City · Denver · Houston · Distributors in Other Principal Cities

Est. 1870

G-E Meter and Instruments Lab Offers Measurement Facilities

The new measurements laboratory of General Electric Company's Meter and Instrument divisions has been opened at Lynn, Mass. Extensive facilities in the brick, steel and concrete building have been provided for G-E's staff of engineering specialists in magnetism, electricity, chemistry, metallurgy, sound, heat, light and color.

Working quarters for laboratory and associated engineering groups and administrative staffs are included in the 142,000 square feet of floor space. Work areas are provided for the three major functional groups—advanced engineering, materials and processes, and general service sections.

Unlimited mechanical and electrical services have been made available to all work areas, the company said. Mechanical services include hot and cold water vacuum, process steam, nitrogen, oxygen, high-pressure air, city gas, and, to two areas where it used in quanity, low-pressure air.

Ethyl Appoints Remondino As Technical Representative

Michael A. Remondino has been named technical representative covering the Eastern sales region and Canada for the Ethyl Corporation research laboratories, Detroit. Remondino succeeds Charles B. Kass who has been named to the staff of the laboratories' newly-created information division. For the past year, Remondino has served as a research engineer in the commercial engine and fleet section of technical service, assisting in liaison activities between the manufacturers of commercial engines and vehicles and the petroleum industry. A member of SAE, Remondino joined Ethyl in 1934 after receiving his degree from the University of Detroit.

Harry A. Toulmin, Jr., formerly assigned to the Ethyl laboratories' automotive research operations division, succeeds Remondino in the commercial engine and fleet section. A 1942 mechanical engineering graduate of the University of Alabama and a member of the SAE, Toulmin joined Ethyl in December of 1945.

Pipe Fabricating Shop Opened In Alberta by Canadian Kellogg

Canadian Kellogg, Ltd., has started operations in a new pipe fabricating shop in Edmonton, Alberta, to make power and process piping in western Canada. The shop is operated by technicians and craftsmen trained in the

5 SQUARE MILES OF ADSORPTIVE SURFACE FOR... $1.00

Dryer than the desert—extremely porous—the multitudinous particles in a sack of FLOREX FULLERS EARTH have a total surface area beyond belief, and an adsorptive capacity unequalled by any other natural material with which we are familiar.

If you are an industrial user of adsorbents for any purpose, Florex and other products of the Floridin Company should be of interest to you.

FLOREX FULLERS EARTH

High-pressure extrusion insures maximum effectiveness.

BAUXITE-BASED ADSORBENTS

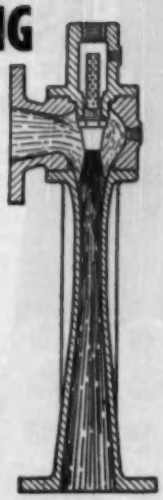
Write for full data. The advice of a competent technical staff is offered. Your inquiry will get prompt attention.

FLORIDIN COMPANY

Adsorbents . . . Desiccants . . . Diluents

Dept. E, 220 Liberty St., Warren, Pa.

the VACUUM PUMP that has NO MOVING PARTS



The steam jet type of vacuum pump has continually gained in favor for high vacuum in industrial process work. The total absence of moving parts is a big advantage and means many years of service, with no maintenance cost unless corrosive vapors are present. Available in single and multi-stage units for vacuum from a few inches down to a small fraction of 1 mm. Hg. absolute.

Many stills, dryers, evaporators, crystallizers and other processing vessels are operating at vacua limited by the vapor pressure of the condensate. This means on the average an absolute pressure of about 2.0" Hg. It is often practical and economical to put a Booster Evactor in the line between the vessel and the condenser and maintain an absolute pressure of 0.5", 0.25" or even lower. The benefits of this higher vacuum in improving quality and capacity are very substantial.

Croll-Reynolds have been manufacturing this type of equipment for over 30 years and have made thousands of separate installations. Their engineers have extensive experience in applying it to numerous different processes. A catalog describing Croll-Reynolds equipment and service is available for the asking.

C-R CROLL REYNOLDS

CROLL-REYNOLDS CO., INC.

17 JOHN STREET, NEW YORK 7, N. Y.

Chill-Vactors Steam Jet Evactors Condensing Equipment

OVER 5 MILLION POUNDS OF service satisfaction

B&W TUBE SUPPORTS are *cast to last* in petroleum processing services — *and they do.* Installations totalling more than five million pounds of these alloy steel castings have been subjected to operating temperatures up to 2000 F, and corrosive, oxidizing and abrasive conditions ranging from ordinary to severe . . . *and not a single service failure has been reported.* Let B&W cast this outstanding service satisfaction into the next tube supports you need for new equipment or replacements. You'll be glad you did.

CAST TO LAST

Products of B&W Engineering for Economy

BABCOCK & WILCOX

techniques employed by the parent company, The M. W. Kellogg Company.

With an approximate monthly capacity of 400 tons, the shop is equipped to fabricate carbon steel and low chrome piping and specialty materials such as stainless steel and high nickel alloys in a full range of pipe sizes.

New IMWI President States Production Defense Policy

Production capacity of member companies in the Industrial Mineral Wool Institute will be geared during 1951 to supplying current and future requirements of defense industry and the military. This policy was announced by E. R. Stevens, Institute president and chairman of the board. Stevens is vice president of Baldwin-Hill Company, Trenton, N. J.

Stevens

In its ninth annual meeting at Hot Springs, Va., the Institute also elected J. S. Blunt of Holmes Foundry Company, Ltd., G. J. Christner of The Eagle-Picher Sales Company, J. A. Buettgen of M. H. Detrick Company and M. W. Butler of Owens-Corning Fiberglas Corporation to the directorate. Frank Christenson of Refractory and Insulation Corporation was elected treasurer and Christner vice president of the Institute.

New Field Sales Organization Setup for Honeywell Valves

An independent field sales organization setup by Minneapolis-Honeywell Regulator Company for its valve division is comprised of regional sales managers and a staff of more than 20 who will promote diaphragm control valves.

R. Schlegel, with New York headquarters, is manager of the Eastern region. Branch salesmen of the region are F. F. Pimentel, William Demorest, Charles Hunter, J. Douglas, D. Douglas, R. Love, and Roy Brown.

In the Mid-Atlantic region, T. L. Smith is manager with headquarters in Philadelphia. Branch salesmen are R. Lempke and H. Frederick. Central region manager with headquarters in Cleveland, is George W. Brown. Salesmen are H. Fox, H. Hoffman, D. Yerks and T. MacDonald.

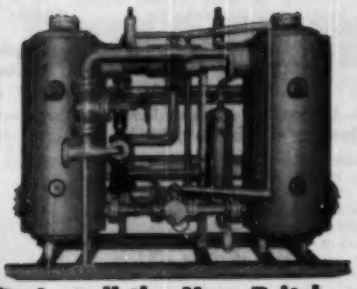
R. R. Scott is manager of the Mid-West region and has his headquarters in Chicago. R. Easter and J. Barolak are branch salesmen.

L. Crowe will work in the Southeast region, out of Atlanta. In Southwest region, C. F. Woods is manager with Houston headquarters. Branch salesmen are F. Benthal and H. Odom.

The Mountain, North Coast and Pacific regions are managed by W. A. Clements with Los Angeles headquarters, and the Northwest region by R. R. Scott.

Sales Manager Is Appointed For H. K. Porter Division

P. J. Gallagher has been appointed general sales manager of Hinderliter Tool Company Division of H. K. Porter Company, Inc. Gallagher, whose headquarters will be at the main office in Tulsa, will direct sales of the company's products,



Install the New Pritchard HYDRYER*...

...for Dependable Dehydration of Air and other Gases

Unexcelled for efficiency in drying air for instrument and process controls. Pritchard HYDRYERS are standard packaged units designed to reduce dew points of compressed air and other gases to minus (—) 40° F. Only service connections are required. Specially designed HYDRYER* units can be built to your requirements.

Write for FREE Bulletin No. 16.0.000 *Registered Trade Name

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HILLS-McCANNA VALVES
MODEL 6800 WITH PLASTIC L-1 DIAPHRAGM
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which include oil well drilling equipment, valves, and air brake parts.

Gallagher was formerly district sales manager for Porter in Detroit and previous to his new post was sales manager for valves at Tulsa.

C. M. Holmes Is Named Manager Of Quaker's Nebraska Plant

Charles M. Holmes, assistant manager of the Quaker Oats Company Memphis chemical plant, has been named manager of Quaker's chemical plant to be built in Omaha, Neb.

Quaker also transferred Alfred M. Price, assistant manager of the mechanical department of the company's St. Joseph, Mo., mill to Omaha as chief engineer. Both Price and Holmes will be in Omaha during construction of the plant.

Sugden Advanced by M M & M, Is Succeeded by Robt. Ingham

C. N. Sugden has been appointed assistant director of engineering for gauges and instruments and Robert Ingham, succeeding Sugden, chief engineer for gauges, Manning, Maxwell and Moore, Inc., has announced.

Sugden joined the company in 1920 in the drafting department and, in 1929, was made chief draftsman. In 1934, he was placed in charge of planning; moving from that position to chief engineer for gauges in 1938. He served on WPB's Industry Advisory Committee during World War II.

Ingham joined the company in 1941 as a development engineer. Previously, he had been an instructor of mechanics in the National Defense Training Program and a design engineer for a gauge manufacturer. He is a graduate of Drexel Institute of Technology.

Compressor Specialist Joins Cooper-Bessemer Engineers

John Fulleman, specialist in engine supercharging and centrifugal compressor design, has been at work for several months with the engineering staff of The Cooper-Bessemer Corporation, coordinating an engine development now under way at the Mt. Vernon headquarters plant. The company's program of research and development in engine supercharging is being accelerated because future demands on gas and diesel engines are expected to call for further increases in horsepower output without corresponding increases in size and weight.

Fulleman

Swiss born, Fulleman received his technical engineering background at the Federal Institute of Technology in Zurich, Switzerland. During the last war he was the field representative for Buchi, Swiss engineering firm, adapting Swiss designed exhaust driven superchargers to American built engines. He is now an American citizen.

Clem Is Appointed Assistant To Pennsalt Vice President

Albert H. Clem has been appointed to the newly created position of assistant to the vice president in charge of sales of the Pennsylvania Salt Manufacturing Company. Clem, who will handle special assignments for the vice president, was formerly assistant manager of sales in the company's Special Chemicals department.

A graduate of Penn State, he joined Pennsalt in 1938 in the Research and Development division. Later he transferred to the Special Chemicals department as sales service representative in the Detroit area and was subsequently product supervisor of Pennsalt cleaners before becoming assistant manager of the department.

Other appointments of the company are Horace F. McIntyre, formerly Philadelphia district sales manager for the special chemicals department, as product supervisor in that department, and John M. Davidson, formerly a sales representative in the Pittsburgh district, as Philadelphia district sales manager.

McIntyre joined Pennsalt in 1943 as special chemical sales service representative. Davidson has been with the firm in the Pittsburgh office since 1946.

Bailey Meter Company Assigns Engineers to Branch Offices

Bailey Meter Company, manufacturer of instruments and controls, has assigned five engineers to new branch office posts. The five are all graduates of the company's intensive training program.

Their names and new business addresses are P. K. Bolyard, 184 Pryor Street, S. W., Atlanta 3; George J.

*TWO low-cost ways to make salvage pay

Either way—tank immersion or steam-detergent cleaning—you save money when you reclaim used parts with job-designed Oakite cleaning and derusting materials. You speed up disassembly, inspection and repair. You save the expense of purchasing new parts . . . save time restoring old parts to condition.

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Tank immersion: Heavy-duty, long-lasting Oakite solution quickly removes grease, caked-on oil, waxy deposits. Excellent for degreasing piping, well tools, pump engines, motor parts, valves, etc. Tank also adaptable to cold solution cleaning with Oakite solvent-emulsion cleaners . . . derusting with specialized Oakite compounds.

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Steam-detergent cleaning: Speedy cleaning of parts too large for solution tank. Removal of heavy, semi-loose deposits before tank-cleaning. Reduces boiling out time, insures longer solution life. Tops for cleaning when equipment urgently needed for production.

Ask your local Oakite Technical Service Representative for on-the-spot demonstration of these money-saving Oakite salvage methods. Or write for booklet F7629. FREE!

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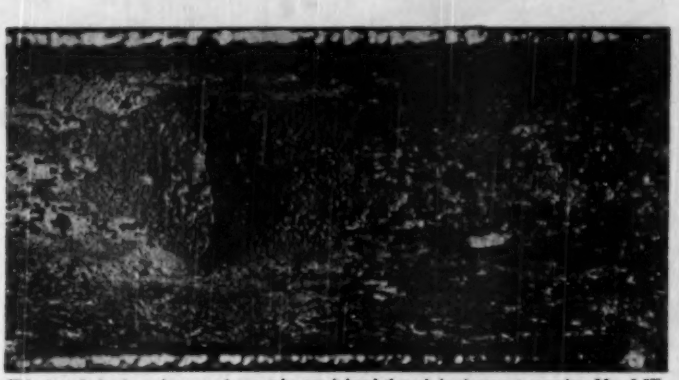
PETROLEUM SERVICE DIVISION

COPPER · ALLOY · BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*



This dented aluminum brass condenser tube was injured through impingement corrosion, Mag 2.5X.

Aluminum Brass Doubles Life of Station's Condenser Tubes

The ability of aluminum brass condenser tubes to withstand impingement corrosion far better than Admiralty is evidenced in a study of operating conditions at a seaboard power station.

Prior to 1937, Admiralty tubes had a life of five to seven years at this plant. Failures occurred both from impingement corrosion at the inlet ends of the tubes and dezincification.

Since retubing with aluminum brass, starting in 1937, there have been no tube failures.

The brackish cooling water used contains considerable entrained air. Marine organisms—algae, slime, clams, mussels and fish—are present.

Water velocities are between 6.8 and 7 feet per second. Turbulent flow at this velocity with entrained air is particularly destructive to Admiralty tubes.

Tube Cleaning Eliminated

Although waterboxes and tube sheets are cleaned at intervals, neither plugging nor any other method of tube cleaning has been found necessary.

Marine fouling is controlled through the use of rotating screens and residual chlorination. Two to three times during each eight-hour shift—depending on the season—chlorine is bled through diffusers into the water flowing through the intake tunnel.

As a means of removing as much air as possible, each condenser is vented at the division plate (two-pass type).

One condenser at the plant has an exceptionally turbulent waterbox which has been attributed to the design of the pump, condenser, and piping. Despite this, the aluminum brass tubes installed in 1937 are just starting to show signs of impingement attack at the inlet ends.

Effect of Impingement Corrosion

In impingement corrosion of Admiralty, the normal protective film is rapidly removed until the base metal is exposed. This exposed metal then corrodes away at a much higher rate than normal. In some materials this may be as much as 50 to 100 times more rapid than the normal rate. The depth of the corrosion pits depends upon the length of time that the stream of water strikes the same spot on the tube wall.

Healing of Tube Film Vital

Rapid healing of broken films is an outstanding characteristic of aluminum brass as well as arsenical aluminum bronze and 70-30 cupro nickel. Films on these alloys may readily repair themselves under conditions where an alloy such as Admiralty would not unless the condenser is completely shutdown. This explains why these alloys withstand impingement corrosion so successfully.

Many stations used to have sufficient capacity so that they could shutdown condensers from time to time. These rest periods allowed the films to rebuild themselves in Admiralty tubes and consequently good service was obtained. Nowadays, these shutdowns seldom occur and therefore satisfactory service life cannot be obtained from Admiralty where severe impingement corrosion is a factor. It is important to use those alloys which stand up better under conditions approximating continuous operation.

Dents Lead to Corrosion

Dents formed on the outside of the condenser tube, resulting from improper handling during shipment or installation, can lead to local failure of tubing. Water striking the bump inside the tube may cut through the protective film of even the more resistant alloys and thin the wall locally until perforation occurs. A similar situation occurs when an obstruction lodged in the tube deflects the stream of water against the tube wall.

The scouring effect of water carrying silt or sand—as well as entrained gases—tend to produce wall thinning.

Since water conditions also affect the rate of impingement corrosion, it is advisable to call on the services of Bridgeport laboratory to help select the alloy best suited to your needs. Write for our Condenser Tube Manual containing information on the corrosion resistance and other characteristics of various tube alloys.

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BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • ESTABLISHED 1865

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Assures Positive Distance Reading of Liquid Levels

JERGUSON TRUSCALE GAGE

THE modern design JERGUSON TRUSCALE GAGE gives new accuracy for reading of liquid levels in boilers, deaerating tanks, etc.

Here is the distance reading gage which incorporates all of the newest engineering features! The Jerguson Truscale has exceptional sensitivity, with the ability to register changes as small as ½ of 1% of range! The translucent dial scale is clearly lighted from behind, and is easy to read.

The Truscale Gage may be equipped with positive alarm system. Lights flash and horns sound at specified key points when liquid level falls dangerously low or rises too high. Foolproof anti-surge mechanism for use on ships. Available for panel, pedestal, or wall mounting. It will pay you to investigate.

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Hydrostatic type distance reading gage with inverted U-tube manometer. Water level always visible with space above showing brilliant red. Built-in feature makes possible checking of gage accuracy in few seconds.

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ETHYL'S WESTERN OFFICES—Ethyl Corporation is erecting this two-story office building in Los Angeles to house its Western region offices. The new structure at the corner of Miramar Street and Huntley Drive will contain 9400 square feet of floor space, with offices, an auditorium, conference room, and food serving facilities. An enclosed parking space will be provided at the rear of the building. The auditorium, which will occupy a one-story section of the building, will have special lighting effects and a full stage with a built-in chassis dynamometer.

Dunegan, 424 Sharon Building, San Francisco 5; L. F. Monahan, 1506 Kearney Street, Denver 7; R. E. Paulson, 7725 Ward Parkway, Kansas City 5, Mo.; and O. M. Thompson, 2509 Carew Tower Building, Cincinnati 2.

Wire Slings Get Trade Name

The line of woven wire slings marketed by The Cambridge Wire Cloth Company, of Cambridge, Md., will be promoted under the name of "Gripper" slings. The slings have spiral wire loops joined together across the body of the sling with special rod reinforcements.

Warner Lewis Firm Transfers Accounts to Charles Wheatley

The Warner Lewis Company of Tulsa has transferred all jobbing and representation of a number of their accounts to Charles Wheatley Company of Tulsa. The accounts include Viking Pump Company, Cedar Falls, Iowa, (rotary pumps); Ralph N. Brodie Company, Oakland, Calif., (meters); Morrison Brother Company, Dubuque, Iowa, (brass goods); Evertite Coupling Company, New York, (quick detachable couplers); Chicago Metal Hose Corporation, Maywood, Ill., (flexible metal hose); and Westco-

Because it's BLAW-KNOX "TWISTED BAR" Electroforged Steel Grating

Blaw-Knox Electroforged Stair Treads available with rolled diamond checker plate nosing, twisted crossbar nosing or abrasive nosing.

THE twist does the trick—twisted bar construction gives greater traction, makes slipping impossible even if the grating is wet, greasy or icy. The slightly roughened surface grips shoe soles for *extra* safety, yet the over-all surface is level. Trucks and other wheeled vehicles roll freely. In addition, Blaw-Knox Steel Grating is electroforged into one piece for extra strength and durability.

OTHER ADVANTAGES: Maximum open area for light and air. Self-cleaning, easy to maintain, economical to install.

GET THE FACTS FROM BULLETIN 2296

Big new bulletin gives complete details, specifications, possible applications and all the outstanding advantages of Electroforged Steel Grating and Stair Treads. Write for your copy today!

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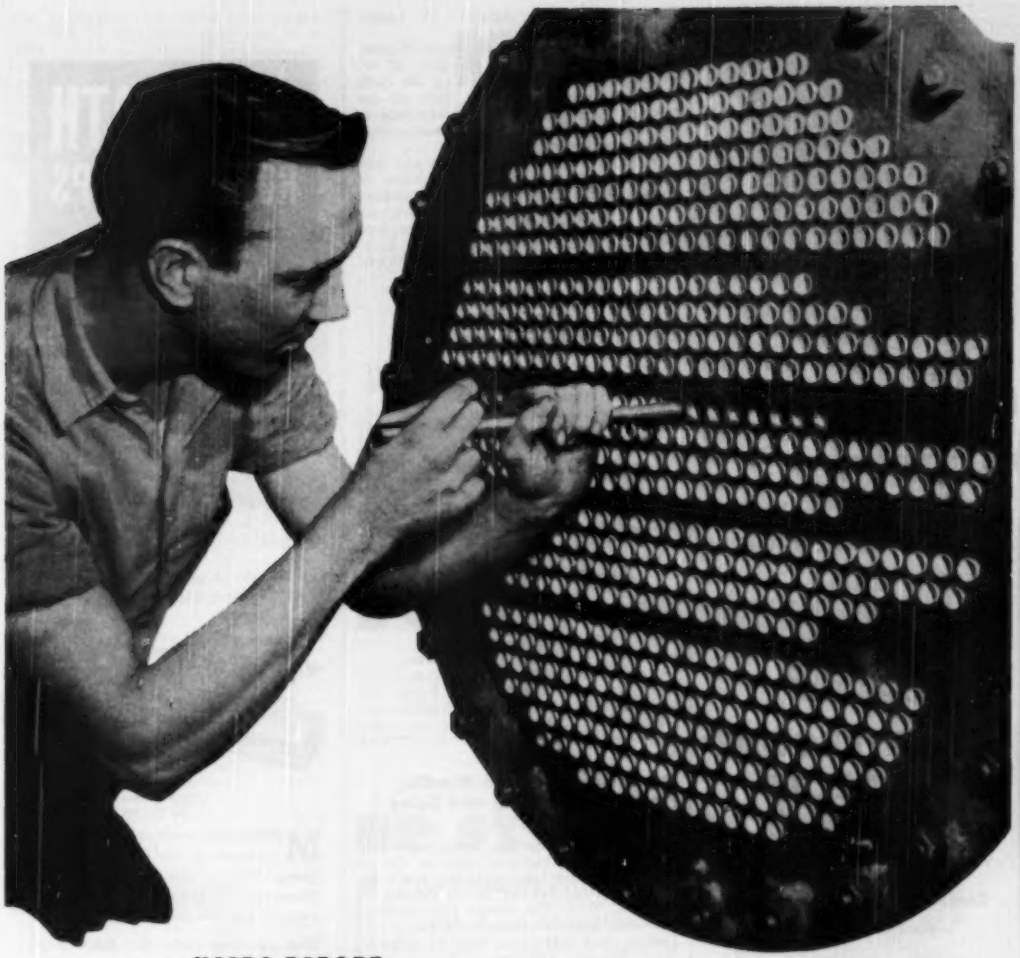
BLAW-KNOX ELECTROFORGED STEEL GRATING



USERS REPORT...

"UP TO 30% FASTER RETUBING WITH ELECTRUNITE"... due to consistently uniform ductility, straightness, diameter and concentricity—qualities which characterize all carbon and stainless steel pressure tubes made by the ELECTRUNITE Welding Processes. Why don't you try them? Write *today*.

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Weathercoat sets to a pliable coating.

Let THIS Remind YOU!

That WEATHERCOAT—

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WEATHERCOAT PROTECTS

the insulation on your hot or cold vessels — for YEARS!

Specified by Leading Refineries for over 15 Years.

Also Try —

MASTIC WEATHERCOAT — New and ready-mixed for void-filling scratch coat.

Ask for specifications and data.

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In the East

AMERICAN BITUMULS COMPANY

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Washington 6, D. C. · Baltimore 3, Md. · Perth Amboy, N. J. · Columbus 15, O. · St. Louis 17, Mo. Baton Rouge 2, La. · E. Providence 14, R. I. San Juan 23, Puerto Rico · Mobile, Ala.

Pomona Pump Company, St. Louis, (turbine pumps).

In addition to these accounts Warner Lewis Company is turning over all inventory of incidental lines to the bulk plant and service station part of the business. The company will continue to manufacture Excel-So water separators, filters and calibrating tanks.

Wheatley is expanding its service and sales department with the addition of James Withers, formerly sales manager of Manning, Maxwell and Moore, together with six salesmen who are now covering the oil field territories of Kansas, Oklahoma, western Arkansas, Western Texas and Louisiana.

Fischer & Porter Appoints District Field Engineer

Fischer & Porter Company has appointed J. B. Carver district field engineer with offices in Tulsa. He will be responsible for the application and service of the company's "Flowrator Meters" and allied instruments in Oklahoma, Texas Panhandle, and southern Kansas.

Carver

Carver received his B.S. degree in mining engineering (with petroleum engineering option) at Missouri School of Mines in 1940. He was a petroleum engineer for The Texas Company prior to entering the Navy, and after the war, joined Odex Engineering Company in Odessa, Texas, as sales engineer.

Stentz Equipment to Handle Pyrene Engineering and Sales

Appointment of Stentz Equipment Company of Tulsa has been named to handle engineering and sales to the oil industry of air foam systems made by Pyrene Manufacturing Company of Newark, N. J. The Stentz organization, including branch offices in Houston and Dallas, will serve throughout Texas, New Mexico, Oklahoma, Kansas, Arkansas, Nebraska, Colorado, Wyoming, Montana, Missouri, South Dakota, western North Dakota and western Louisiana.

Nelson Gauge Company Assets Purchased by Natasco, Tulsa

The Natasco Company of Tulsa has purchased the patents, shop and equipment of Nelson Automatic Gauge Company, also of Tulsa. The latter company manufactures a complete line of equipment which permits quick gauging of an unlimited number of tanks, from distant control stations.

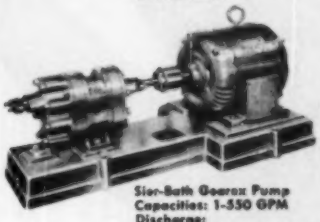
Plans for early manufacture by the Natasco Company are progressing rapidly and the Nelson gauges will soon be available in all oil production and refining areas, officials declared.

Manning & Lewis Engineering Adds Tonkonogy to Staff

Manning & Lewis Engineering Company of Newark, N. J., has appointed Alwin Tonkonogy of Process Plants Engineering Company, Newark, as engineering consultant and sales representa-

SIER-BATH ROTARY PUMPS for uninterrupted service

Sier-Bath Screw Pump
Capacities: 1-700 GPM
Discharge:
1000 PSI for viscous liquids
250 PSI for water



Sier-Bath Gearex Pump
Capacities: 1-350 GPM
Discharge:
250 PSI for viscous liquids
50 PSI for water

Maintenance — not price — is the true measure of the cost of a rotary pump. That is why Sier-Bath Rotary Pumps are designed to provide uninterrupted, maintenance-free service.

Features that make Sier-Bath Screw Pumps and Gearex Pumps top performers at all times include:

No metallic contact between rotors.
External bearings for handling non-lubricating liquids.
Low pressure on stuffing boxes reduces packing maintenance.
Direct connected to motors at standard speeds up to 1800 RPM.
Available in corrosion-resistant alloys.

Write for descriptive bulletin.

Also manufacturers of Sier-Bath Precision Gears and Sier-Bath Gear Couplings.

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Sier-Bath GEAR and PUMP CO., Inc.

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tive. Tonkonogy will assist in expanding the "M&L" heat exchanger line to include agitated process reactors, agitators, mixing equipment, rotary dryers, crystallizers, evaporators and similar chemical process equipment.

Tube Turns of Canada Names Manager of Western District

Wayne E. Williams has been appointed Western district manager for Tube Turns of Canada Limited. His office is at 110 Clark Building, Edmonton, Alberta.

Williams

Williams, who majored in engineering at the University of Southern California, has had 20 years' experience in the petroleum, chemical and power fields, and formerly was with C. F. Braun & Company and W. M. Barnes Company, Ltd. The past two years he was project engineer for the erection of a major refinery at Antwerp for the Raffineries Belge des Petroles.

Edward Valves Names Manager For Pittsburgh Area Sales

Thomas E. Skilling has been appointed Pittsburgh district sales engineer for Edward Valves, Inc. As Edward representative in the area, he succeeds the Herr-Harris Company, with whom he has been associated for several months. He will continue his office at 545 William Penn Place.

A graduate mechanical engineer of Lehigh University, Skilling has been with Edward in home office engineering and sales work since 1947.

The Herr-Harris Company has been affiliated with the Edward organization more than 30 years.

Scientific Glass Apparatus Moves to Larger Quarters

Scientific Glass Apparatus Company, Inc., has transferred its offices and plant to 100 Lakewood Terrace, about 1000 yards from its former address in Bloomfield, N. J. The new headquarters is a brick and concrete structure purchased in 1949 from Clark Thread Company. The floor area comprises more than 100,000 square feet on one level with a basement of equal size for storage.

During the more than 30 years since the company's founding, the old quarters were enlarged three times, the last in 1941 when the plant was doubled in size.

H. K. Porter Sells Quimby

Quimby Pump Division of H. K. Porter Company, Inc., has been sold to Warren Steam Pump Company, Inc. T. M. Evans, president of Porter, explained that the Warren Company is equipped to handle the servicing of Quimby pumps, and Porter is withdrawing from the manufacture of screw pumps in order to devote itself to other lines of business.

Adds Three New Licensees

The Insul-Mastic Corporation of America has added three licensees to its national organization. They are Insula-

REDUCING FITTINGS

are a "Natural" with

LENAPE PRESS FORMING

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Lenape, seamless welding necks, nozzles, manways, swing-type covers, and other accessories for vessels of all kinds, are available in a complete range of standard and special sizes. Write today for Bulletin 4-61. Your blueprints and specifications will be given our immediate attention.

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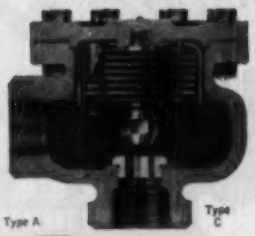
UP STEAM FLOW 50%

for Leading Processor

A striking increase in steam flow from 2000 to 3000 lbs. an hour is reported by a chemical maker who recently replaced a mechanical trap with Nicholsons. This cut cooking time from 105 to 55 min., a gratifying speed-up of 48%. Also widely recommended for their effective venting of non-condensible gases in critical applications.

5 TYPES FOR EVERY PURPOSE—Process, heat, power; size ¼" to 2"; press. to 225 lbs. BULLETIN 450.



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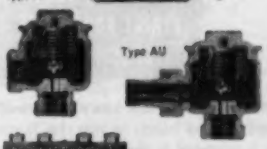

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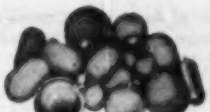

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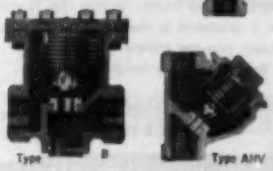

Type B Type AHV

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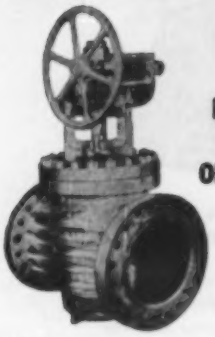
ALL PURPOSE
STEEL VALVES



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PRICED to compete with conventional plug-type valves. Interchangeable with American Standard Steel Wedge Gate Valves. Wrench-Operated; Direct Handwheel-Operated; Worm Gear-Operated; Sizes from 1" to 16". Write for our Catalog No. 600 and Price List. On request, we will be glad to quote on larger sizes above 16".

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tion Engineers, Inc., Conception Street Road, P. O. Box 815, Mobile, Ala.; Industrial Roofing & Sheet Metal Company, 4815 Lexington Avenue, Cleveland; and R. F. Zimmerman & Company, 1121 Spring Street, P. O. Box 1721 Shreveport.

Cooper-Bessemer Increases Staff at Odessa, Texas

Clayton L. McDougall has been appointed sales and engineering representative at its Odessa, Texas, office by The Cooper-Bessemer Corporation.

McDougall

A graduate engineer from the University of Cincinnati, McDougall has been associated for over six years with this engine and compressor builder at its headquarters plant in Mt. Vernon, Ohio. Under the direction of Arthur W. Abel, Jr., branch manager, his new sales engineering duties will concentrate on gas and diesel engines, engine-driven compressors and liquid pumps for petroleum processing and transmission service.

De Laval Steam Turbine Names Representative for Mexico

De Laval Steam Turbine Company of Trenton, N. J., has appointed Consultores Y Abastecedores Industriales, S. A., Dolores 17-301, of Mexico, D. F., as its representative in Mexico. Their representation covers the entire Republic with the exception of the mining companies in Northern Mexico, which are handled for De Laval by Roger Brown Company of El Paso, Texas.

Consultores Y Abastecedores Industriales will handle De Laval steam turbines, centrifugal compressors and blowers, centrifugal pumps, speed reducers, couplings and IMO screw type rotary pumps.

General Controls Expands Sales and Service Facilities

General Controls, Glendale, Calif., has expanded its sales and service facilities. R. D. Hollingsworth has been added to the staff and will cover the Cleveland, Buffalo and Cincinnati trade territory. He will specialize in refrigeration controls. Hollingsworth will work out of the Cleveland branch office and will call on dealers, jobbers and manufacturers.

J. B. Miller, who will have headquarters in Washington, D. C., will call on various government agencies in the interest of the company's line of aircraft controls.

General American Opens New Storage Terminal at Chicago

General American Transportation Corporation has opened a fifth public tank storage terminal for chemical and petroleum products. Located for service to the entire Midwest, the new Chicago terminal offers various size tankage with loading and unloading facilities.

Equipment is leased, enabling the customer to have private storage without investment or risk of capital. Centrally situated in Chicago's Clearing Industrial District, at 67th and Archer on the Sanitary and Ship Canal, the new terminal is serviced by all of the railroads which come into Chicago.

ESPECIALLY RECOMMENDED
FOR USE IN THE
Copper
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is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

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- Steam Atomizing Oil Burners
- Refractory Burner and Muffle Blocks
- Industrial Gas Burners
- Low Air Pressure Oil Burners
- Fuel Oil Pump Sets
- Valves, Strainers, Furnace Windows
- Tandem Block Combustion Units
- Combination Gas and Oil Burners

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FREE

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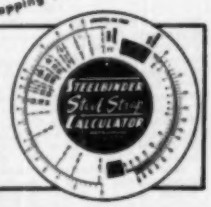

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Boiler

1—Union Iron Works Type L 3950 sq. ft. surface, 300 psig WP 3-drum, WT, complete with gas burners, feedwater controls, breeching and 5'6"x125'¼" welded plate stack.

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Gilbert & Barker Firm Adds Houston Sales Representative

Thomas Whelan, Jr., of The Whelan Company, Houston, is handling the sale of Gilbarco bubble trays and instrument housings in Louisiana and eastern Texas. The appointment was made by Gilbert & Barker Manufacturing Company of West Springfield, Mass.

Whelan, a graduate chemical engineer, has had 12 years' experience in refinery-apparatus work. For the past four years he has been engaged in engineering sales.

John C. Ruf Retires as Manager Of Ohio Injector Sales District

John C. Ruf, for ten years Philadelphia district sales manager of The Ohio Injector Company of Wadsworth, Ohio, has retired from that company. Paul E. Warner succeeded him in the Philadelphia post.

Active in the mill supply business for many years, Ruf is a past president of American Supply and Machinery Manufacturers' Association, Inc.

Kenneth Fox Joins Kinney As Sales Application Engineer

Kenneth Fox, formerly a vacuum metallurgist with National Research Corporation, has joined Kinney Manufacturing Company of Boston as sales application engineer. He will assist customers in the solution of problems involving the use of vacuums and will be in charge of a program for determining new applications for Kinney vacuum pumps and associated products in the fields of low pressure processing.

American Air Filter Sets Up Division Headed by Hellstrom

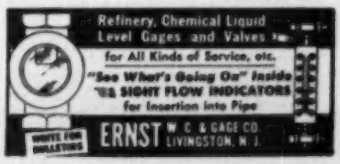
John Hellstrom, vice president of the American Air Filter Company, Inc., Louisville, Ky., will be manager of the newly created Pacific division. His office will be in the Standard Oil Building, 225 Bush Street, San Francisco.

Under Hellstrom's supervision will be the business activities of both American Air Filter Company and its Herman Nelson division of Moline, Ill., in the Pacific territory. The new division includes the representatives in California, Oregon, Washington, Idaho, Montana, Utah, Arizona, New Mexico and the western part of Texas.

Warren F. Doty Joins Warren

Edward F. Doty, designer of screw and rotary pumps, now is associated with Warren Steam Pump Company, Inc., Warren, Mass. For many years Doty has been with Quimby Pump Company, which was purchased by Warren Steam Pump recently.

With Quimby, Doty specialized in design and application engineering. He was the originator and developer of the modern method of computing screw capacities, friction and slippage losses in screw and rotex pumps.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ADVERTISERS

in the November, 1950, issue of

Petroleum Refiner

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A

*Acrofin Corp. 72
Air Reduction Magnolia Co. 238
*Aircool Manufacturing Co. 213
Alan Wood Steel Co. 194
*Allied Chemical & Dye Corp. 14
*Allis-Chalmers Manufacturing Co. 9, 11
*Aluminum Company of America 25, 86 and 255
American Bitumuls Co. 230
The American Brass Co. 201
American Cyanamid Co. 6-7
*American Locomotive Co. 93
American Smelting & Refining Co. 243
American Steel & Wire Co. 34
The Anmin Co. 188
Armstrong Cork Co. 203
*Armstrong Machine Works 5
*Aurora Pump Co. 240

B

*The Babcock & Wilcox Co. 244
*The Babcock & Wilcox Tube Co. 18
*E. B. Badger & Sons Co. 36-37
*Baldwin-Hill Co., Inc. 230
*Beaver Pipe Tools, Inc. 235
Bethlehem Steel Co. 76
W. H. & L. D. Betz 228
*Black, Sivalls & Bryson, Inc. 210
*Blaw-Knox Co. 174, 225 and 240
*Born Engineering Co. 221
Bridgeport Brass Co. 247
The Bristol Co. 19
*Buell Engineering Co. 226

C

Calumet & Hecla Consolidated Copper Co. 50
*Cameron Iron Works, Inc. 58
Carnegie-Illinois Steel Corp. 34
The Chapman Valve Manufacturing Co. 64
Chase Brass & Copper Co., Inc. 175
*Chemical Construction Corp. 52
Chicago Bridge & Iron Co. I Cover
Classified Advertising 253
Columbia Steel Co. 34
*The Continental Supply Co. Opposite 224
*The Cooper-Bessemer Corp. 163
*Crane Company 24
*Croll-Reynolds Co. 243

D

Dallas Tank Co., Inc. 220
Davis Engineering Corp. 222
The Davison Chemical Corp. 157
*Dean Brothers Pumps Inc. 220
*Dresser Industries, Inc. 172 and 180
E. I. du Pont de Nemours & Co. 82
*The Duriron Co. 218
Durametallic Corp. 216

E

*The Eagle-Picher Co. 26-27
*Eastern Industries, Inc. 240
*Elliott Company 84 and 227
*Engineers & Fabricators, Inc. 62
*Ernst Water Column & Gage Co. 253
Ethyl Corp. 44-45

F

Federated Metals Division 239
*Fisher Governor Co. 10
Flexitallic Gasket Co. 94
*Flint Steel Corp. 232
*Floridin Co. 243
The Flour Corp. 46
*Foster Wheeler Corp. Insert 32-33; 164-165
The Foxboro Co. 178

G

*General American Transportation Corp. 182
*General Electric Co. 16-17 and 88-89
A. J. Gerrard & Co. 253
Gilbert & Barker Mfg. Co. 70 and 236
Goodall Rubber Co. 242
Graver Tank & Manufacturing Co. 30
A. P. Green Fire Brick Co. 63
*Grinnell Co. 20
*The Gulf Publishing Co. 235

H

Hagan Corp. 171
*Hamer Oil Tool Co. 215
Hartzell Propeller Fan Co. 209
A. L. Henderer's Sons 205
Hudson Engineering Corp. Opposite 65

I

*Industrial Division, Minneapolis-Honeywell Regulator Co. 29 and 169
*Ingersoll-Rand Co. 69
*International Engineering, Inc. 214
The International Nickel Co. 31 and 231

J

The C. O. Jelliff Mfg. Corp. 205
*Jerguson Gage & Valve Co. 248
*Johns-Manville Corp. 212
*The Johnston & Jennings Co. 204

K

*Kennedy & Mattison, Inc. 65
*The M. W. Kellogg Co. 73 and Insert 192-193
*The C. M. Kemp Mfg. Co. 195
Kerlow Steel Flooring Co. 235
*The Key Co. 42
Kidder, Peabody & Co. 234
*The Koch Engineering Co. III Cover

L

Lacy Manufacturing Co. 23
*Ladish Co. Opposite 64
Landis Machine Co. 8
Layne & Bowler, Inc. 255
Lenape Hydraulic Pressing & Forging Co. 251
*The Lummus Co. 60-61

M

Manning, Maxwell & Moore, Inc. 77
*Mason-Neilan Regulator Co. 8-9
The Master Electric Co. 200
*Arthur G. McKee & Co. 161
Metal Textile Corp. 199
*Midwest Piping & Supply Co. 40
*Minneapolis-Honeywell Regulator Co. 29 and 169
*Mixing Equipment Co. 12-13
Mt. Vernon-Woodberry Mills, Inc. 233
*Mundet Cork Corp. 202
*Murray Iron Works Co. 193

N

*National Airoil Burner Co. 232
*National Carbon Division Union Carbide & Carbon Corp. 206
National Lead Company 33
*National Technical Laboratories II Cover
National Tube Co. 34
Newport News Shipbuilding & Dry Dock Co. 217
*W. H. Nicholson & Co. 251
*Nordstrom Valve Division Rockwell Manufacturing Co. Insert 96-97

O

*Oakite Products, Inc. 246
*The Ohio Steel Foundry Co. 181
Orbit Valve Co. 167

P

*Pabco Products Inc. 197
*Pacific Pumps, Inc. 180
*Page Steel & Wire Division American Chain & Cable Co. 39
*Palmer Thermometers, Inc. 196
*The Patterson Foundry & Machine Co. 71
*Penberthy Injector Co. 155
*Petro-Chem Development Co. 67
Petroleum Chemicals Department American Cyanamid Co. 6-7
*Petroleum Rectifying Co. 237
Phelps Dodge Refining Co. 252
*Pittsburgh Corning Corp. 53
Pittsburgh Lectrodryer Corp. 47
Posey Iron Works, Inc. 78
The Wm. Powell Co. 38
*The Pressed Steel Co. 28
*J. F. Pritchard & Co. 31 and 245
*Proportioneers, Inc. 256

R

*R-S Products Corp. 184
Reading-Pratt & Cady Division American Chain & Cable Co. 66
The Refinery Engineering Co. 176
*Republic Steel Corp. 21 and 249
*Research Corp. 241
*Revere Copper & Brass, Inc. 153
*The Ridge Tool Co. 185
Rochester Manufacturing Co. 241
*Rockwell Manufacturing Co. Insert 96-97
*Rockwood Sprinkler Co. 223
*Roots-Connersville Blower Corp. 172
Rust-Oleum Corp. 186

S

Shand & Jurs Co. 74
Shell Development Co. 43
Sier-Bath Gear & Pump Co., Inc. 250
*Sims Pump Valve Co. 230
Solvay Sales Division Allied Chemical & Dye Corp. 14
The Edward Soph Co. 245
Stancal Asphalt & Bitumuls Co. 250
Standard Oil Company of California Opposite 225
*Strong, Carlisle & Hammond Co. 199
*Sun Shipbuilding & Dry Dock Co. 68
Superior Manufacturing Co. 235

T

*Taylor Instrument Companies 56-57
Tennessee Coal, Iron & Railroad Co. 34
*The Terry Steam Turbine Co. 54
The Timken Roller Bearing Co. 4
Nicolay Titlestad Corp. 179
Tretolite Co. 75
Turner Halsey Co. 233

U

*Union Asbestos & Rubber Co. 41
*Union Carbide and Carbon Corp. 206
United States Steel Corp. 34
United States Steel Export Co. 34
United States Steel Supply Co. 34
Universal Oil Products Co. 48-49 and 253

V

Victor Products Corp. 252
*Henry Vogt Machine Co. 32

W

*Wallace & Tiernan Products, Inc. 210
Walworth Co. 35
Warren Petroleum Corp. 190
*Watson-Stillman Co. 173
Wedgeping Valve Co. 252
Well Equipment Mfg. Corp. 187
*Weston Electrical Instrument Corp. 177
C. H. Wheeler Mfg. Co. 22
Wheeling Corrugating Co. 211
*The Gustav Wiedeke Co. 234
A. R. Wilfley & Sons, Inc. 55
Wolverine Tube Division, Calumet & Hecla Consolidated Copper Co. 50
*Worthington Pump & Machinery Corp. 15
Wyatt Metal & Boiler Works IV Cover

Y

*Yarnall-Waring Co. 30
*Otto H. York Co. 80

Z

*Zallea Brothers 79

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with aluminum scaffolds

Photo courtesy of Up-Right Scaffolds

Save half the usual maintenance time with one of these new scaffolds of Alcoa Aluminum. Workmen easily assemble the sections and hoist them in place in 20 minutes, thanks to aluminum's light weight. With workmen on each platform, once around the tank finishes the job. Write for a list of manufacturers who make these better, lighter scaffolds. ALUMINUM COMPANY OF AMERICA, 1424L Gulf Building, Pittsburgh 19, Pennsylvania.

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Quality in Well Water Systems or Vertical Turbine Pumps cannot be designated as the one and only element that makes them worthwhile. To quality, so Layne has long known, there must be added a lot of very skillful designing, extra precision in building, plus the overall know-how that can only come from years and years of world-wide experience. The result of such a combination is something that lasts, gives satisfaction and credit to the name of Layne.

Layne is primarily interested in selling a constant, dependable and economical water supply. To do this successfully, Layne has long been the producer of the finest water supply equipment the world has ever known.

It is such a service and such fine equipment that you buy when you become the owner of Layne Well Water Systems and Layne Vertical Turbine Pumps. They are more widely used than any other make in the entire world—a wonderful tribute to their excellence.

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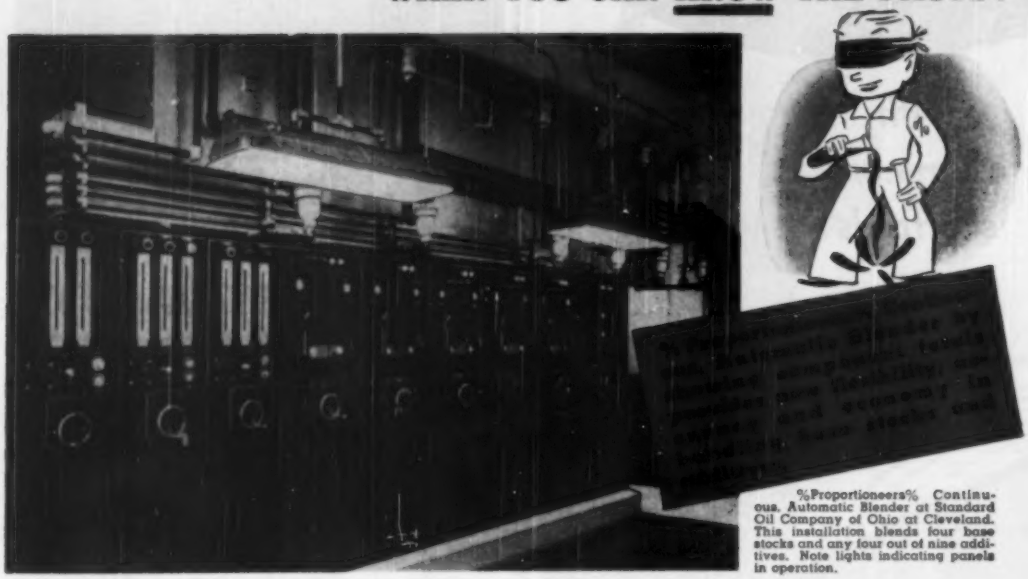
WHY WORK *Blind*

WHEN YOU CAN KNOW THE FACTS?



%Proportioneers% Continuous Automatic Blender at Standard Oil Company of Ohio at Cleveland. This installation blends four base stocks and any four out of nine additives. Note lights indicating panels in operation.

1 **Blender operation** is controlled from a single drum switch on master panel with "test" position during which individual components are recirculated within the machine and *totalizers show* whether component settings are correct.

2 **Production capacity** is controlled from master panel and can be altered within a 1 to 3 range without affecting the pre-set percentages of base stocks and additives.

3 **"Band Spread" feature** permits setting additive proportions to within .01% of batch. Viscosity of finished product will be within ± 2SSU if incoming base stocks are uniform. Infinite flexibility in setting component percentages, with same degree of precision in setting percentage of a small component as of a large component.

4 **Electrical interlocks protect quality of finished product:** Upon failure of any component to reach the machine, all panels will automatically return to "recirculation", cutting off blend manifold. Any shortage is automatically made up so finished product will be on specification at end of run.

5 **Tally meter** throws blender back on "recirculation" after adjustably pre-set batch of finished product is completed.

6 **Warning lights** show panel in use and designate *which* component has failed and *why*.

7 **Automatic blow-back feature** to clear any line or lines is built into each panel.

8 **Mixers** with or without dehydration feature are optional.

9 **All wiring is in explosion-proof conduit** for class 1, Group D hazardous locations.

10 **Construction is unitized:** all base stock and additive panels are of uniform design and can be assembled in any grouping; extra panels can be provided at any time for additional components or increased plant capacity.

% PROPORTIONEERS, INC. %

Write to %Proportioneers, Inc.%, 412 Harris Ave., Providence 1, R. I.

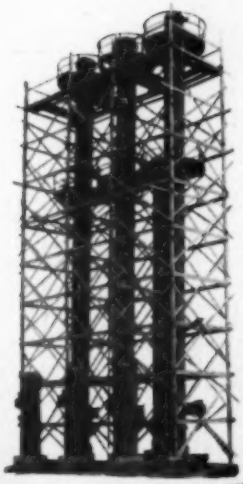
Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

NUMBER 2 OF A SERIES

Our installation time was only 1½ manhours for each 3-foot tray

and the Koch Kaskade fractionating trays in our new gasoline plant are operating fine!

PEPPERS REFINING COMPANY



SATISFIED by the operation of Koch Kaskade trays in another of their gasoline plants, Peppers naturally specified them in all the towers of their new gasoline plant at Britton, Oklahoma. These towers include an absorber, stripper, deethanizer, depropanizer and a debutanizer.

A LARGE number of Koch Kaskade tray installations are repeat orders from satisfied customers. It will pay you to investigate the economy and operating efficiency of Koch Kaskade fractionating trays. Write us today, no obligation.

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